ANNALS OF SURGERY

VOL. 101 APRIL, 1935 No. 4

THE RÔLE OF PLASTIC SURGERY IN BURNS DUE TO ROENTGEN RAYS AND RADIUM

By Sir Harold D. Gillies, C.B.E., F.R.C.S.

AND

A. H. McIndoe, M.Sc., M.S., Minn.; F.R.C.S.

of London, England

FROM THE PLASTIC SURGICAL SERVICE, ST. BARTHOLOMEW'S HOSPITAL, LONDON, ENGLAND

The widespread use of radium and roentgen rays as therapeutic agents and their well-recognized potency for evil as well as for good has not unnaturally resulted in a considerable number of cases of radiodermatitis and radionecrosis. In comparison with the enormous number of treatments by radiation given daily in all parts of the world, the actual number of cases is small. Yet they constitute a definite group of patients and a formidable one because of the pain and distress associated with the condition, its intractability to conservative treatment and its medico-legal importance.

Many of the cases are a legacy of work at a time when protective measures were poor and when soft rays were in general use. Others occur at the present time due to over-treatment, to inadequate protection of the patient or to deliberate heavy dosage for malignant disease. This aspect is important for it must not be forgotten that in sustaining overdosage effects, many patients have been cured of conditions far worse or at least far more lethal.

The well-recognized latent period between the exposure and the appearance of the dermatitis also explains why it is that certain radiumologists declare that radiodermatitis is today practically extinct. He is frequently unaware of having produced a burn because it appeared years after the rays had been applied and after the patient had disappeared. In one instance the patient and radiumologist met 19 years after the original treatment when the former was being shown at a medical congress as an example of plastic treatment of radiodermatitis. The radiumologist concerned had never known that his patient had sustained a serious and disabling burn.

More than 100 cases have been seen in the last 15 years and of these about one-half have submitted to operation. The subject is one that deserves closer attention than it has received in the past for an inquiry into the histories of these patients shows that the majority have spent years and often large sums of money in seeking relief by various conservative treatments and have only too often been finally told that nothing could be done

about it. This lack of interest is reflected in medical literature where comparatively little has appeared in the past ten years. The medical profession should appreciate that the condition of chronic radiodermatitis is essentially a surgical one and in as much as a graft of some kind is almost always required, it should fall within the field of plastic surgery.

At the recent Radiological Conference in London a symposium was held on this subject to which my colleague, Mr. A. H. McIndoe, and I contributed. The clinical aspect was dealt with by Professor N. S. Finzi.[1] We wish to present to you a further report on our experience in this condition and where necessary have drawn freely on the contributions of others at that conference.

Clinical Groups

An examination of the series shows that the patients fall naturally into three groups:

Group I.—Patients who have received a single dose of roentgen ray or radium for diagnosis or treatment. In some cases the dose was not excessive, pointing to an individual susceptibility. In others it was massive and definitely too heavy. In one patient an extensive lesion of the back resulted from a single fluoroscopic seance and the ulcer lasted for ten years. In another, radiodermatitis and necrosis of the skin of the wrist followed one roentgen ray examination for a fractured scaphoid. A single therapeutic dose for pruritis ani produced acute extensive necrosis of the buttocks and perianal skin. In such cases acute necrosis followed within a short time of the administration of the dose. In all of these the resultant chronic ulcer failed to heal and surgical treatment was required. Cancer was not found in any case.

Group II.—Patients who have undergone treatment for a chronic condition and have received small but frequent doses for a long period often resulting in ulceration. This is by far the largest group. Almost all patients with lupus treated by roentgen ray exhibit burns of varying severity. Psoriasis, ringworm, acne, eczema, pruritis ani, kraurosis valvae, naevi, superfluous hair and many other superficial affections are included. Deep roentgen therapy for exophthalmic goiter, tuberculous glands, uterine fibroids and various forms of cancer were also responsible. Dermatitis in this group was characteristically chronic from the outset and in many cases progressed to sluggish ulceration. Epitheliomatous changes were demonstrated in about six per cent of the patients.

Group III.—Professional workers with roentgen ray apparatus suffering from burns of the hands and face: This group might well be included in the second but it is particularly significant to the medical profession and has a melancholy interest to those workers in roentgen rays who sustained their injuries at the time when protective measures were inadequate. Fortunately, modern methods have materially reduced this incidence.

Etiology

The effects described are purely and solely the result of roentgen rays or gamma rays upon the cells of the radiated tissue, but it is important to point out that radiation from other sources may intensify this effect. Thus ultraviolet light given before or after quite normal doses of roentgen rays may cause typical roentgen ray damage of considerable degree. Infrared rays and strong sunlight may have the same effect. The practical point emerging from this is that ultraviolet light or infrared rays or indeed sunbathing should not be advised before or after any operation on these patients. Finzi[1] emphasizes the danger of treating roentgen ray burns, keratoses or epitheliomata with full doses of radium: for while a temporary good result may be obtained, the cumulative ray damage is consequently of very severe degree and disastrous results are produced.

Pathology

The destructive effects of roentgen rays and gamma rays are attributable to two processes:

(*a*) Vascular obliterative changes in the arteries, veins, capillaries and lymphatics resulting in interference with nutrition of the skin. Wolbach showed that the deep skin and the subcutaneous tissues received the brunt of the injury and that an obliterative endarteritis results, by whose steady progress the latent period is explained.

(*b*) Loss of function of the cells in the radiated area, according to the particular susceptibility of the cells and the intensity of the radiation: Regenerative capacity is reduced to its lowest point or disappears altogether. This influence is most marked on specialized cells and least on the fibroblast. The anemic necrosis produced by these processes is peculiar in that no definite line of demarcation forms as in ordinary anemic gangrene and there seems to be sufficient vascularity in the surrounding area to keep the devitalized tissue from dying outright. Where definite ulceration has occurred, there is inadequate reaction on the part of the surrounding tissues to cast off the slough and it often remains as a yellow fibrinous membrane covering the exquisitely painful and sensitive ulcers. Although these ulcers may, if treated with extreme care, heal for a time, they more frequently break down, especially under the influence of secondary infection.

The Acute Lesion.—After an excessive single dose which produces acute necrosis, the lesion consists of a central slough where the more intense rays have produced massive cell death, surrounded by an extensive zone of inflamed skin which the less powerful rays have produced circulatory and functional changes without actually killing the cells *en masse*. During this period when gangrene is marked and secondary infection is a prominent feature, the inflammatory reaction is so widespread that no pathologic or surgical line of demarcation between healthy and devitalized tissue can be defined. Indeed, none exists and at varying periods fresh sloughing may occur.

The Chronic Lesion.—When the chronic lesion follows an acute necrosis

the passage of months or years allows a slow contraction and absorption to take place. The ulcer shows very little evidence of repair, and its indolent, painful base, devoid of all granulations, remains covered by a yellow crust from beneath which a serous discharge slowly oozes. As the full force of the radiation is usually felt in the ulcerated area, fixation of the base to deeper structures such as muscle and bone is not uncommon and in not a few instances the latter may lie exposed and occasionally sequestrates. Muscles and tendons appear dull white and completely fibrosed, though preserving their shape and form. When the chronic lesion is due to repeated small doses, the sequence of events is characterized by an insidious change in the quality and function of the skin and by a slow depression in its vitality. Some or all of the peculiar features of telangiectasis, pigmentation, thickening and scarring of the corium, atrophy of the skin with disappearance of the sweat and sebaceous glands and the hair follicles, cracks and fissures, keratoses and malignant growths, make their appearance. When the balance between regeneration, tissue vitality and resistance to infection is upset, intractable ulceration makes its appearance. Not all the cases progress to ulceration though it might fairly be said that except in the very slight cases one cannot foretell those which will not eventually do so. The ray damage is cumulative, the obliterative process progressive and the latent period may vary from three or four months to twenty years.

Particular Features

(*a*) *Telangiectasis.*—These appear from one to three years after the initial ray damage, although if radiation is intense, they may start within four months. In the milder cases there is a tendency for them to disappear after four or five years. They may involve only a few vessels and small patches or they may become confluent and cover a large area with a continuous sheet of dark red vessels. The skin itself after the appearance of telangiectasis is never normal, though the change in its texture may be difficult to detect. According to Finzi[1] they appear to be much more common after exposure to roentgen rays than radium and are particularly caused by the old method of full doses every three or four weeks.

(*b*) *Pigmentation.*—This is a constant accompaniment in almost every case and varies in amount according to the patient's skin. As the skin changes become more pronounced and atrophy more severe, it tends to become patchy in distribution.

(*c*) *Atrophy of the Skin.*—The skin acquires a curious, smooth, wrinkled, papery character, indicating that the sweat, sebaceous glands and hair follicles are completely destroyed. Study of the condition of the skin at this stage impresses one with the danger of attempting epilation by roentgen rays.

(*d*) *Thickening of the Skin.*—With the slow establishment of the well-developed chronic form of dermatitis, the whole thickness of the skin becomes involved so that it feels hard and leathery and assumes a mottled appearance due to a patchy pigmentation; cracks tend to appear in this thickened dry skin and may actually form small linear ulcers.

(*e*) *Keratoses.*—The wart-like excrescences commonly seen on the hand may follow both acute and chronic radiodermatitis. In the former they rarely tend to become epitheliomatous. In the latter there is a distinct tendency for epithelioma to develop.

It is important to emphasize these points, first to make clear the restricted field for conservative treatment and secondly to indicate the necessity for adequate excision of all the devitalized tissues at a suitable time in order to prepare a healthy foundation for grafting.

Indications for Operation

Not all roentgen ray burns demand immediate surgical treatment. Many of the milder cases heal, become quiescent and remain symptomless, leaving nothing but a patch of telangiectasis or mildly thickened skin. Again, acute massive necrosis should be for a time conservatively treated until the extent of the gangrene is determined and secondary infection has subsided. In my experience, about one-half of the cases presenting themselves for treatment are considered operable for the following reasons:

(1) *Pain, Itching, Ulceration.* As a rule, with chronic ulceration the patient complains of exquisite pain which produces a condition of mind and body miserable in the extreme. In the telangiectatic and rind-like areas an intolerable itching may drive the patient to despair. The relief of pain and irritation and the mental improvement which usually follow immediately the area is excised are most striking.

(2) *Deformity from Contraction.* As a rule, this is very much less marked than with burns by fire, owing to the complete absence of keloid and the smaller amount of fibrous tissue formed. This is most frequently met with in patients who have undergone extensive treatment for diseases, such as lupus, which by themselves produce contraction. It is rather a feature of the condition treated than of the treatment. In the neck a certain amount of retraction of the chin and eversion of the lower lip may take place. Contraction deformities also occur in the neighborhood of the eyes and nose.

(3) *Cosmetic Appearance.* The unpleasant and disfiguring appearance of the skin, especially on exposed parts, in the milder degrees of burn unaccompanied by ulceration can frequently be greatly improved by grafting. A knowledge of the ultimate cosmetic appearance of grafts of various types is essential in settling this question.

(4) *Epitheliomatous Change.* Only in long-standing ulcerative radiodermatitis is cancer prone to supervene, but the possibility of its presence can never be excluded by superficial inspection. Microscopic examination of the excised area should, therefore, never be omitted.

Treatment

Surgical treatment falls naturally into the two stages of (*a*) excision and (*b*) repair and in the vast majority of cases both stages are carried out at one operation.

The exceptions to this rule are the acute or badly infected ulcer where a stable equilibrium has not been reached or in one where a healthy base is not obtained after primary excision. Here it is advisable to divide the operation into two stages and to allow the base to granulate before grafting. It is certain that the too early application of grafts in these cases is hazardous and may give poor results.

From a surgical point of view, the distinguishing feature of chronic radiodermatitis is that the whole area can be dissected up from the subjacent tissues with ease, there being a well-marked cleavage plane between normal and devitalized structures. This cleavage plane is rather surgical than pathologic, for the transition from healthy to devitalized tissues is certainly not pathologically abrupt as in other forms of gangrene. Nevertheless, it is a comparatively simple matter to dissect the affected area, including the involved fasciae, muscles, tendons or bone lying beneath the ulcer. When this is done, it will be found that the surface so exposed is sufficiently vital to receive a graft. Excision should extend into healthy skin on all sides. A guide to its depth is furnished by traction on the tough superficial tissues, the cleavage plane being thereby established and easily followed. It is sometimes wise, however, to leave the deep scar in important organs such as the thyroid, or in important tendons and trust to the good effect of a healthy full-thickness skin flap. Where this is the case, razor grafting is inadvisable. If epitheliomatous change is suspected, the operation should be performed with a diathermy knife and microscopic examination of the edges and base of the excised area carried out to prove the completeness of the excision. In these cases every effort must be directed to thorough removal of the diseased tissues without thought to the problem of the subsequent repair. It is here, too, that the anxious decision must be made as to the advisability of conservative surgical treatment such as excision and grafting as against amputation and removal of the regional lymph nodes. This is particularly true in the case of roentgen ray workers. Fortunately, it is uncommon for epithelioma on the fingers due to roentgen ray burns to metastasize early and speaking generally true recurrences are rare. The method of repair depends on the quantity of tissue lost, the age and sex of the patient, the position of the defect, the cosmetic result desired and the mechanical problem of transporting the graft to its new position. Three methods are available—(*a*) Thick razor grafts; (*b*) full-thickness dissected grafts; (*c*) direct flaps and tubed pedicles.

(*a*) *Thick Razor Grafts.*—These, applied on a stent pressure mould of the defect, have a wide field of use, and the method is the simplest and most certain available for covering the raw area. Although the immediate result is sometimes disappointing, in that the graft may be wrinkled, hard and depressed, it later becomes soft, smooth and filled out and the result compares very favorably with those of other methods. Thick razor grafts are used as a routine on the hands and fingers of roentgen ray workers; on the scalp and back where large areas must be covered; and on the eyelids for the

relief of cicatricial ectropion. On the front of the neck the method is advisable where a quick result rather than cosmetic excellence is aimed at. It is not so applicable where a thick covering is desirable for weight bearing, or where pressure is to be exerted on the surface of the graft.

(*b*) *Full-Thickness Dissected Grafts.*—In the writer's opinion the higher standard of technic for a successful result demanded by this type of repair and its tendency to subsequent mild trophic disturbance do not justify its use in place of other more certain methods.

(*c*) *Pedicle Flaps.*—These may be of the sliding, rotated, transposed or tubed pedicle variety, according to the difficulties to be overcome and the cosmetic result desired. They are particularly applicable where appearance is important, where much tissue has been lost, and where a mobile covering is required for exposed structures. Their chief fields of usefulness will be found in extensive lesions on the cheek, neck and limbs, and particularly where joints are involved. They are, in fact, useful in almost any situation except on the hands and fingers. On the scalp, small areas may frequently be obliterated by rotated flaps of neighboring healthy scalp, with or without thick razor grafting of any remaining bare area, so arranged that the hair can conveniently conceal the deficiency. Thus, in both sexes it is advisable to transpose a bare area from an anterior to a more posterior position so that it can be more easily hidden. More complete loss of the scalp should be covered by thick razor grafts and a toupee should be worn.

Roentgen ray lesions of the face involve many problems in plastic surgery associated with the nose, lips, cheeks or eyelids and the same principles are involved in this type of repair as with burns from any other cause.

Discussion of Illustrations Depicting the Applicablity of the Principles Involved

Fig. 1 shows an example of thick razor grafting in the eye socket of a roentgen ray worker in whom exenteration became necessary. It was not considered advisable in this case to remake the eyelids because of the extent of the disease and amount of destruction that had occurred. The use of a direct flap is well illustrated in Fig. 2 where a full-thickness skin flap from the left shoulder gave a quick and cosmetically satisfactory result in two operations. As a rule, secondary disfigurement of the chest or shoulders is avoided in women but there need be no hesitation in using a forehead flap as the secondary defect can easily be hidden by the hair. In

Fig. 1.—Radiologist. Thick razor graft after exenteration of orbit.

men this is not so easy and the acromiopectoral flap has a wider application. When a specific objection is raised to any disfigurement of forehead or chest and a good cosmetic result is desirable, one must have recourse to the abdominal delayed flap or the author's tubed pedicle method with an intermediate host such as the wrist.

(*a*) (*b*) (*c*)

FIG. 2.—(*a*) Roentgen ray treatment for lupus. (*b*) Repair by direct shoulder flap. (*c*) Results six months after operation.

Figs. 3 *a* and *b* show an example of a unilateral cheek replacement, the flap being obtained from the previously amputated left arm.

(*a*) (*b*)

FIG. 3.—(*a*) Original condition of lupus of face. Amputation of tuberculous arm. Roentgen ray treatment of face followed by epithelioma and subsequently radium burn. (*b*) After replacement of cheek by flap from amputation stump.

Figs. 4 *a* and *b* record a not uncommon complication in the region of the lips and cheek. Here a burn due to radium involved all thicknesses of the cheek and obliterated the lower right buccal sulcus. In addition to an

external covering it was necessary to supply a lining before a satisfactory result could be hoped for. This was obtained by the Sidcup modification of the Esser inlay in which the adhesions between the lip and mandible are separated and the raw area and cavity so left is covered with a thin razor graft cut from the inner side of the arm. Pressure is maintained by a stent mould impression of the cavity held by a dental plate and tray. This having been carried out, the external covering was supplied by a neck flap. The treatment of roentgen ray dermatitis of the nose largely depends upon the amount of tissue lost and varies from a simple thick razor graft in the more superficial types to complete rhinoplasty by a modern forehead flap or tubed pedicle method, where the nose has been completely or almost completely lost.

FIG. 4.—Necrosis (radium) through all thicknesses of cheek. Repair: Externally by flap—internally by buccal inlay.

On the neck, according to the age and sex, thick razor grafts or a pedicle graft is usually employed. In children and in many women the former is satisfactory.

Figs. 5, 6 and 7 are three examples of roentgen ray burns of the neck in which this relatively simple method was employed with results which, while not cosmetically perfect, were quite satisfactory to the patient. In

FIG. 5.—Roentgen ray treatment for toxic goiter. Repair by thick razor graft on mould.

this connection it is worthy of note that while the neck is an extremely difficult part of the body to immobilize for the purpose of grafting, we have long abandoned the practice of plaster fixation of the head on the trunk and

prefer to rely on the use of Tulle Gras or Stents Modelling Compound after sewing the skin into position, pressure being applied by a bandage. The patient's head is carefully immobilized between sandbags for three or four days.

FIG. 6.—Roentgen ray treatment: T. B. glands.

Repair by thick razor graft on mould.

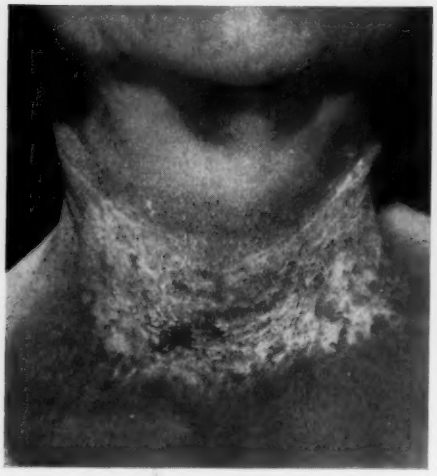


FIG. 7.—Roentgen ray treatment for exophthalmic goiter.

Repair by thick razor graft on mould.

The more complicated but cosmetically superior method illustrated in Figs. 8 and 9 shows the use of the adbominal tubed pedicle, transferred *via* the wrist and finally spread on the neck after excision of the devitalized area. This entails at least four operations, but the results justify it. A more difficult problem is represented in Fig. 10, where a most extensive loss of tissue

FIG. 8.—Roentgen ray treatment for exophthalmic goiter.

Repair by abdominal tubed pedicle flap.

FIG. 9.—Roentgen ray treatment for exophthalmic goiter.

Repair by abdominal tubed pedicle flap.

FIG. 10.—Large pharyngeal fistula following deep roentgen ray treatment; larynx and trachea previously excised for cancer. Repair by inturned lining flaps and external tubed pedicle flap. Figure shows flap in position before pedicle was divided and released.

resulted from complete laryngectomy for carcinoma of the larynx followed by intensive roentgen ray therapy to the region of the pharynx and esophagus. The difficulty of supplying the lining of the pharynx was here satisfied by inturned flaps from each side, raised and delayed for 14 days because of their poor nutrition. The external surface was obtained by a left acromiopectoral tubed pedicle. On the tenth day the patient was able to swallow food by mouth. He had been unable to do this for five years.

FIG. 11.—Chronic ulcerative radiodermatitis of both axillae following treatment for removal of hair. Axillae showing lesions and result after treatment by thick razor grafting.

Roentgen ray lesions of the axillae are usually bilateral and result from an illadvised attempt at the removal of axillary hair. They are particularly distressing owing to intolerable itching. Anterior and posterior sliding flaps partly fashioned from any excessive skin covering the breasts will give a fairly good cosmetic result though this may mean extensive remodeling of the breasts to make good the secondary defect. Thick razor grafts applied on axillary moulds probably give as satisfactory a result as any as seen in Fig. 11.

Lesions of the arms may also be simply dealt with by means of razor

(4) (1)

(5) (2)

(6) (3)

FIG. 12.—(1) Roentgen ray treatment for psoriasis both elbow regions, 1923. Ulcerative radiodermatitis right elbow appeared 1928. Picture shows condition when first seen in 1930; left elbow similarly affected but not quite so severe. (2) Condition of right elbow, 1934. (3) Result after immediate repair by direct full thickness flap from right thorax; otherwise normal. (4) Result after original treatment and prior to repair. (5) Result following excision and repair by direct full thickness flap from left thorax. (6) Present condition of both elbows showing range of movement.

grafts or better still by direct flaps raised from the side of the chest or abdomen and fitted into the defect. The correct design and transference of direct flaps from one part of the body to another is of importance on both the upper and lower limbs and a successful result can be achieved only where an accurate preoperative plan has been evolved. The method long used by me, but only recently published, has given great satisfaction. It enables a direct flap to be raised in the correct situation on one limb and applied accurately to the deficient area on the other without danger to the base of the pedicle. The principle of the method is to imagine the operation completed and then to reverse the steps of the transposition in every detail with a tinfoil model of the flap. The pattern of the excised area is held in the position the graft is intended finally to occupy. Still maintaining the pattern in this position, the limbs are suitably crossed, or the arm brought into the most favorable position at the side. Half the tinfoil pattern is then maintained in its final position while the other half, forming the base of the pedicle, is applied to the side of the body or to the opposite limb in a satisfactory position so that no constriction of the blood supply can occur. This half is then held fixed to the donor area. The other end is released from the area to be excised and flattened out on the donor area. The area from which the flap is to be raised and the part which is to form its bases are now accurately determined and can be marked out by scratching. The stages of the actual operation reverse this entire process using the skin flap instead of the model. An interval of two or three weeks occurs between the attachment of the pedicle flap to the excised area and its final division from the donor area.

Fig. 12 shows an interesting example of this type of repair and at the same time illustrates many interesting features of radiodermatitis. The patient was first seen with well marked ulcerative radiodermatitis of the right elbow region three years after its establishment and eight years after roentgen ray treatment had been given for psoriasis. The left elbow had been similarly treated but at that time showed very little evidence of ray damage.

Fig. 12 (1) and (2).—The ulcerated area on the right side was excised and covered with a direct flap raised from the side of the chest. Fig. 12 (3). —A year later after a period of serious worry occasioned by her husband's death and probably producing a general depression in health, she returned with acute radionecrosis of the left elbow [Fig. 12 (4)] similar in character to that on the right. She had had no ray treatment for nine years on this elbow and the skin here appeared almost normal at the time of the first operation. Identical treatment by a direct flap from the left side was carried out, the final result being shown in Fig. 12 (5) and (6).

Thick razor grafts (Fig. 13) or direct flaps from the opposite calf or thigh may be used for the repair of lesions of the legs, the latter being almost essential around the ankle joint or heel where weight bearing, pressure and movement are of importance.

On the anterior abdominal wall roentgen ray burns usually result from the intensive treatment of uterine or ovarian tumors. Here, fortunately, repair is most easily effected by sliding flaps after excision, for such lesions

FIG. 13.—Roentgen ray treatment for psoriasis of leg. Repair by excision and thick razor graft.

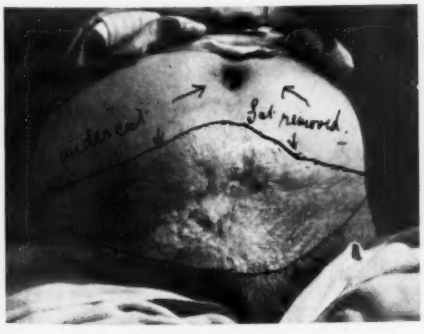


FIG. 14.—Roentgen ray treatment for fibroids. Treatment by excision and sliding flaps.

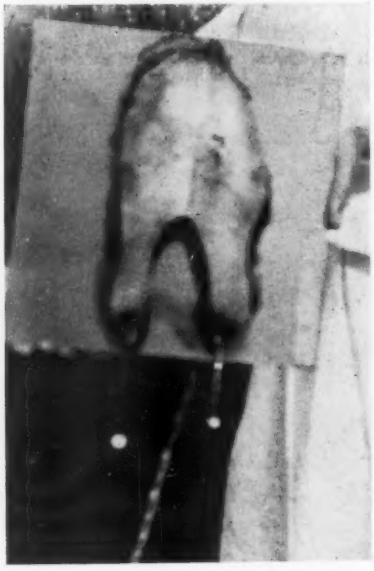
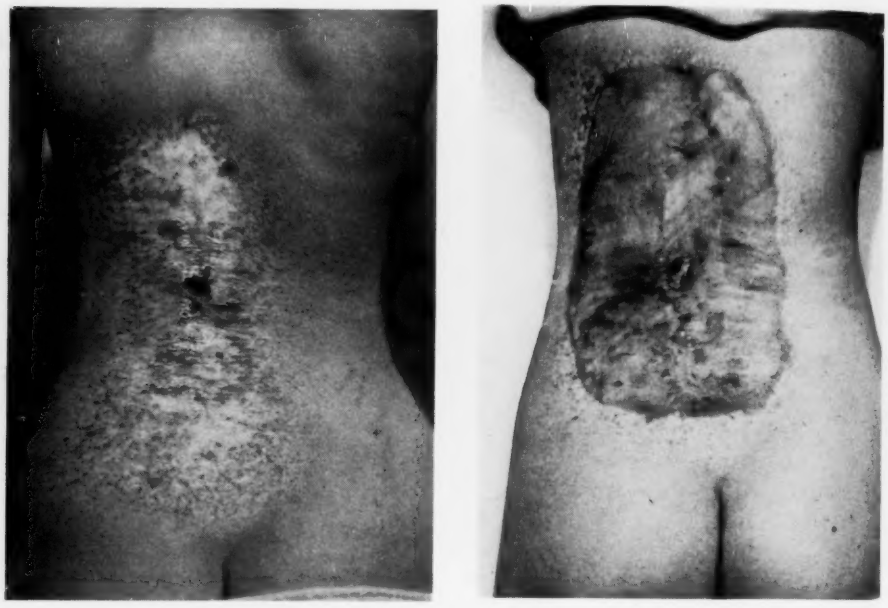


FIG. 15.—Roentgen ray treatment for pruritis ani—picture shows tissues removed. Repair by sliding flaps.

extend down to the peritoneum and a healthy bed for free grafts is difficult to obtain (Fig. 14).

Burns in the perianal region due to treatment for diseases of the rectum and external genitalia are also best treated with sliding flaps, extensive mobilization of the skin of the buttock giving an adequate amount of tissue to cover what appears at first an alarming deficiency (Fig. 15).



(*a*) (*b*)

FIG. 16.—Chronic ulcerative radionecrosis following screening of barium meal twelve years previously. Excision and application of thick razor grafts effected a quick cure.

(*a*) (*b*)

FIG. 17.—(*a*) Fingers of radiologist. (*b*) Repair by thick razor graft.

Radiodermatitis of the back may occur in conjunction with burns of the anterior abdominal wall where deep roentgen ray therapy of the pelvis

has been given or they may be more superficial from fluoroscopic examination. Fig. 16*a* shows the result of a single prolonged fluoroscopic examination of a child of three. For ten years various attempts had been made to cure the ulceration without success. Complete excision and razor grafting

(*a*) (*b*)

FIG. 18.—(*a*) Radiodermatitis of palm of hand accentuated by ultraviolet rays. (*b*) Repair by thick razor graft.

(*a*) (*b*)

FIG. 19.—(*a*) Hand of roentgen ray worker. (*b*) Repair by thick razor graft.

brought this about in a short time. Fig. 16*b* shows the grafted area three weeks later.

Radiodermatitis of the hands and fingers is of particular interest to the medical profession. One cannot but feel that many valuable lives might have been saved and many amputations avoided had excision and grafting been resorted to at an early stage. Here the thick razor graft is almost uniformly successful and the functional result excellent. Full-thickness flaps are unnecessary even when tendons are exposed and their presence on the palm of the hand is most undesirable. Isolated keratoses on the dorsum and fingers should be excised and resutured if possible, but where this is impossible, sufficient new skin should be inserted. Fig. 17 shows the fingers of a radiumologist which have been grafted from the nail beds of the middle and ring fingers to the proximal interphalangeal joints.

FIG. 20.—Severe necrosis of facial structures due to roentgen ray treatment for hair follicle infection.

Radiodermatitis of the palms of both hands incidentaly made much more severe by ultraviolet ray is equally well treated by razor grafting (Fig. 18). On the dorsum very large areas may be dealt with in this manner (Fig. 19). It is interesting to note how a large razor graft on the hands, although applied directly over the tendons, vessels and nerves, rapidly loses its firm early adhesions to those structures and becomes freely mobile and soft within a few months.

CONCLUSIONS

It might be said that the best results are obtained with thick razor grafts and flaps and that the cosmetic excellence of a repair in this type of burn is superior to that after burns by fire. The relief of pain is immediate and permanent as soon as excision is complete, even though nothing further is done and the area left to granulate.

The surgical result of healing by granulation is, however, usually deplorable owing to contraction deformities which are certain to follow. Success depends entirely on the technical excellence of the plastic treatment.

REFERENCE

[1] Finzi, N. S.: Late X-ray and Radium Effects. Incidence, Etiology, and Radium Effects. Brit. Jour. Radiol., vol. 6, No. 63, March, 1933.

ZINC PEROXIDE IN THE TREATMENT OF MICROAËROPHILIC AND ANAËROBIC INFECTIONS

WITH SPECIAL REFERENCE TO A GROUP OF CHRONIC, ULCERATIVE, BURROWING, NON-GANGRENOUS LESIONS OF THE ABDOMINAL WALL APPARENTLY DUE TO A MICRO-AËROPHILIC HÆMOLYTIC STREPTOCOCCUS

By Frank L. Meleney, M.D.

of New York, N. Y.

ASSISTANT PROFESSOR OF SURGERY, COLUMBIA UNIVERSITY, N. Y. C.

FROM THE BACTERIOLOGICAL RESEARCH LABORATORY, DEPARTMENT OF SURGERY, COLLEGE OF PHYSICIANS AND SURGEONS, COLUMBIA UNIVERSITY, AND THE SURGICAL DEPARTMENT OF THE PRESBYTERIAN HOSPITAL, NEW YORK

The routine use of anaërobic methods of bacterial cultivation has brought light to bear on a number of unusual as well as common surgical infections.[1, 2, 3, 4, 5]

This presentation is concerned with a group of six chronic, ulcerative, burrowing, non-gangrenous lesions of the abdominal wall apparently due to a micro-aërophilic hæmolytic streptococcus. Their chief interest lies in the response of the last three of these cases to local treatment with zinc peroxide.

Certain observations have been made regarding the behavior of this organism both in the wound and in the test tube following the application of zinc peroxide, and this paper will serve as a preliminary report for a wider investigation of the effect of zinc peroxide and other peroxides on infections caused by micro-aërophilic and anaërobic organisms in general, and on the behavior of these organisms *in vitro*.

CASE REPORTS

Case I.—In 1926, a patient was admitted to the Presbyterian Hospital presenting an unusual infection (B.H., Unit History No. 65158). The essential characteristics of the infection were: A chronic ulcer of the right groin following the incision of an inflamed inguinal gland six months before. Instead of healing in the usual way, the margins of the wound became undermined and the free edges of skin began to thin out, retract and melt away. There was never any gangrene of the skin but the ulcer gradually became larger. The skin became undermined and perforations from beneath produced small holes which gradually became larger and fused with the main ulcer. The infection spread by a liquefaction of the subcutaneous tissue and skin. He had been treated in three other hospitals before coming to us. When he entered the hospital the lesion appeared as in Fig. 1. Under most of its circumference the skin was widely undermined, the deepest burrowing extended down beneath the crease of the groin into the thigh and scrotum. He was seen by all of the surgeons on the staff, all of the dermatologists and several outside men. No one claimed ever to have seen anything like it before. Many diagnoses were made, every kind of antiseptic solution and salve was tried in an effort to control the infection. It was incised, excised and skin grafted unsuccessfully. Salvarsan, tartar emetic and transfusions were given without avail. Fig. 2 shows the lesion four months after admission. The patient was in our hospital from March until December, 1926, and then went home considerably worse than when he came in and with his morale completely shattered. He had a bad contracture of the thigh and he frankly wanted to be relieved of his misery by death. He improved somewhat at home, but four months later he was admitted to the hospital because of a severe hæmorrhage from a sinus in the wound. The sinus led down

FIG. 1.—(Case I.) On admission five months after onset of disease. Note undermining of skin with rolled-in margin. Skin is adherent at upper inner quadrant with recent growth of epithelium.

FIG. 2.—(Case I.) Four months after admission, nine months after onset of disease. The process had extended down the thigh and into the scrotum and outward over the crest of the ilium.

into a large pelvic abscess. The abscess was packed with four yards of gauze but the bleeding could not be controlled and he died in twenty-four hours, evidently from the involvement of a large pelvic vessel, one year and seven months after the onset of his infection. Repeated bacteriological studies of the lesion showed a varying bacterial flora. Hæmolytic streptococcus, *Staphylococcus aureus* and *albus* and *Bacillus coli* were all found at one time or another. The hæmolytic streptococcus was found in some cultures and absent in others. Its significance was not then appreciated. No anaërobic cultures were made.

Case II.—Six months later I was asked to see a patient at the Misericordia Hospital by Dr. A. H. Schmitt. A young married woman who had lived for a number of years in Cuba and South America developed an ectopic pregnancy. Her doctor diagnosed it pelvic abscess and did a posterior colpotomy. Finding blood-clot, he went in above and removed a left pregnant tube. A pelvic abscess developed which worked up toward the

Fig. 3. Fig. 4.

Fig. 3.—(Case II.) On admission, two years after onset of disease. Note the rolled-in margins and the skin undermining down beneath the crease in the groin and up above the level of the umbilicus. Note also the spontaneous daughter ulcer in the thigh.

Fig. 4.—(Case II.) On admission. The undermining of the skin in the groin has broken out spontaneously through the skin of the vulva.

right lower quadrant. This was drained and the drainage persisted for months. Finally, the margins of the wound became undermined and retracted. An ulcer developed in the groin and spread slowly in all directions. Neighboring areas of skin became thinned out and perforations developed from beneath, which grew larger and fused with the main ulcer. There was never any gangrene of the skin but the subcutaneous tissue became extensively liquefied, up above the level of the umbilicus and back around the flank almost to the spine. Every local and general medication which the doctor could think of was applied. She spent months on a boat exposing the wounds to Florida sunshine, without avail. The process continued to spread, she continued to lose weight, strength, courage and morale. When I saw her I recognized the infection as being similar to the preceding case but had little to offer in the way of advice for her care. Tuberculosis, syphilis and actinomycosis were ruled out by tissue examination. We tentatively diagnosed it "granuloma inguinale." This diagnosis was confirmed by Alexander Randall, of Philadelphia, and F. W. O'Conner, of our own department of tropical diseases, although the latter thought that it was an unusual form. She seemed to show temporary improve-

ment with antimony, particularly in the trivalent and pentavalent forms, but the improvement was never striking and was always followed by relapses. I made a careful bacteriological study of the wound flora both anaërobically and aërobically. *Bacillus coli*, *Staphylococcus aureus* and *Staphylococcus albus* grew on the aërobic plates while a hæmolytic streptococcus appeared on the anaërobic plates. From one sinus this organism was obtained in pure culture. For that reason it was thought to have some significance. This streptococcus was not a true anaërobe, however, for when subsequent artificial cultivations were made, it gradually became more and more capable of growing aërobically. We therefore classified it as a "micro-aërophilic hæmolytic streptococcus." We made vaccine and Besredka filtrates from this organism. We injected the vaccine and administered the filtrate both subcutaneously and locally. At times the wounds seemed to improve after the application of the filtrate but improvement was always followed by discouraging retrogression. She finally showed signs of amyloid degeneration of the

FIG. 5.

FIG. 6.

FIG. 5.—(Case II.) Three months after admission. The lesion has healed in some areas but advanced in others.

FIG. 6.—(Case II.) Three months after admission. Twenty-seven months after onset of disease. The undermining has spread further in the groin and vulva.

kidneys, liver and spleen. Then Doctor Schmitt asked me to admit her to the Presbyterian Hospital (C.P., Unit History No. 79456). Figs. 3 and 4 show her condition on admission, then two years after the onset of the infection. In this hospital we intensified the use of pentavalent antimony, believing that the underlying cause was *granuloma inguinale*, but she steadily went down hill. Finally, after three months without improvement (Figs. 5 and 6), with nothing else to offer and at the urgent request of the patient and her family, I attempted to completely eradicate the infection by excision, but while dissecting the sinus into the pelvis I entered the peritoneum. She died four days later with general peritonitis from which both the streptococcus and *Bacillus coli* were cultured.

CASE III.—The third case in the series was a private patient of Dr. W. P. Healy's at the Roosevelt Hospital. She had been ill for one month with a painful mass in the left lower quadrant of the abdomen. At operation a peritoneal abscess was found and was drained both directly and by a counter incision in the flank. The pus had a foul odor. The bacteriologist reported a streptothrix. No anaërobic cultures were taken. The abscess continued to discharge profusely through both wounds during her two months' stay in the hospital, and for five months while she was at home. She was, therefore, readmitted

and a lipiodol injection revealed a large deep pocket near the rectosigmoid. The sinuses were partially excised and the abscess curetted. Dakinization failed to improve the condition. The wounds were irrigated with Lugol's solution and she was given heavy doses of iodides without improvement. Irradiated oil was likewise ineffective. She left the hospital after one month, and a month later was readmitted with the condition worse, for the skin below the original site had become undermined and the infection was evidently spreading subcutaneously. Three weeks later the skin perforated from beneath and an ulcer formed. Dr. Howard Patterson, who was the doctor then in charge of the case, asked me to see her. The history and appearance of the wound resembled Case II. Aërobic cultures yielded no growth but anaërobic cultures again yielded the micro-aërophilic hæmolytic streptococcus and likewise a green non-hæmolytic micro-aërophilic streptococcus. Streptothrix was not found. Specimens of the tissue showed no evidence of tuberculosis, syphilis, actinomycosis or blastomycosis. On the basis of our former experience I advised a radical excision, but she began to improve and radical procedures were postponed. She left the hospital again after two months and received ultraviolet-ray treatment. The sinuses continued to drain for seventeen months and then finally closed spontaneously. The whole course lasted twenty-six months. Unfortunately, no photographs were taken.

Case IV.—The fourth case was a private patient of Dr. L. S. Herndon's, in St. Michael's Hospital in Newark, N. J. A year previously she had had an interval appendix removed. The wound became infected, and, instead of healing, it continued to discharge. After six months the infection began to undermine the skin and a large ulcer formed which gradually enlarged by a process of undermining and liquefaction of the margin. It was evident that this case was clinically similar to the other cases. Anaërobic cultivation of the exudate yielded the micro-aërophilic hæmolytic streptococcus in pure culture. I now felt certain that this organism was significant, and again I prepared vaccine and Besredka filtrate. They were used without any evidence of improvement. A wide excision failed to stop its progress. Fig. 7 illustrates the extent of the lesion at that time. Antimony had no effect. Maggots were tried and nearly drove her insane by their activity. The wound improved slightly but maggots had to be abandoned. Her morale was completely shattered; the pain in the wound could hardly be controlled with large doses of morphine and she contemplated suicide. In the meanwhile we had been studying the organism with renewed interest. Its preference for an anaërobic environment suggested the use of a peroxide to inhibit its activity. I asked Dr. Hans Clarke and Dr. Edgar Miller, of the Department of Biological Chemistry, if they could not suggest a peroxide that would yield its oxygen over a relatively long period of time rather than give it off abruptly. After some deliberation, Doctor Clarke suggested zinc peroxide. This chemical has been used commercially for some time as a bleaching powder but recently the Du Pont Chemical Company of Niagara Falls has made a fine grade for medicinal purposes, which they call "Z.P.O." The fact that it would yield oxygen over a period of days and then leave the bland zinc oxide, with which we are all familiar, made the suggestion an appealing one. The idea was carried through at once. A creamy suspension of the powder was made in sterile water and applied to the wound. Within three days it was evident that there was a favorable reaction. In a week the whole appearance of the patient and the wound had changed. Her morale returned, fever and pain subsided, the undermined flaps began to become adherent. Cultures taken from the wound were reported by the hospital laboratory to indicate that the organism was now growing aërobically. Blood-plates were not used for these cultures so that we do not know whether the organisms recovered at that time were hæmolytic or not. As soon as the flaps were sealed down, new skin began to grow in from the margins. Soon it was possible to apply skin grafts. The zinc peroxide was stopped. The wound then healed over rapidly except for two small areas in the groin where the skin margin was rolled in. In one of these areas a sinus was beginning to form. Fig. 8 shows the condition at that time. This sinus persisted for several months after the patient

FIG. 7.—(Case IV.) One year after onset of illness. One week after excision of lesion. The undermining process continued unabated.

FIG. 8.—(Case IV.) One month after skin graft. The area well covered except for two small areas in the groin with rolled-in skin margins. A burrowing sinus had developed in the lower one in the depths of which the micro-aërophilic hæmolytic streptococcus was found but which finally healed with careful applications of zinc peroxide.

Fig. 9.—(Case V.) On admission to the surgical service two months following a hysterectomy on the gynecological service. Note the sinus formation and the undermining of the skin. This is the earliest case in the series.

Fig. 10.—(Case V.) The injection of zinc peroxide revealed extensive undermining of the skin and a sinus extending down into the pelvis.

left St. Michael's. She finally came over to our hospital for a culture to be taken directly from the sinus. The micro-aërophilic hæmolytic streptococcus was again found deep down in the sinus. Zinc peroxide was then applied more conscientiously to the depths of the sinus and it finally closed.

CASE V.—The fifth case (M.A., Unit History No. 366345), a Negress of forty-two, was seen on the wards of Sloane Hospital two months after a hysterectomy had been done following a D. and C. No drains were used. When the uterus was opened a gold wishbone pessary was found inside. The wound became infected and three sinuses persisted, all pouring out large quantities of pus. Fig. 9 shows the appearance of the wound at that time. No cultures had been taken. When we made an anaërobic study the micro-aërophilic hæmolytic streptococcus was found in pure culture. We injected the sinus with a watery suspension of zinc peroxide and took an X-ray picture to show its extent. The zinc outlined the cavity and tract clearly (Fig. 10). It revealed large subcutaneous pockets on either side and a sinus extending deep into the pelvis. The sinus openings were connected by an incision and the subcutaneous pockets were laid bare. Thereafter, the wound was irrigated daily with saline, and zinc peroxide suspended in 1 per cent. gelatine was instilled, the gelatine holding the powder in a more even suspension than the water, in which it tended to settle and cake. The response to the treatment was immediately favorable. The temperature fell, the patient felt better, and the wound contracted. Soon it was impossible to enter the sinus tract with a small catheter but an X-ray film showed that there was a large mass of fragmented zinc peroxide deep in the pelvis, probably a portion of that originally injected in the watery suspension judging by its fragmented appearance. The abscess was obviously behind the rectum (Fig. 11). This was evacuated from the rear, and when the crumbly ZnO_2 had been completely removed, the wound healed promptly. In the meanwhile the anterior wound closed rapidly (Fig. 12).

Three days after the zinc peroxide was first used, cultures were taken from the wound, and the only organism which we could recover was an aërobic green streptococcus which was not found at the primary examination. What had become of the original organism? The only two plausible explanations seemed to be either that the micro-aërophilic hæmolytic streptococcus had been killed off and the green aërobic streptococcus had been introduced, or that the original organism had become changed or dissociated in the wound following the application of the zinc peroxide. When these two cultures were tested for their ability to grow in culture media in the presence of zinc peroxide, Miss Balbina Johnson, working in the Surgical Bacteriology Research Laboratory, found that the original culture not only failed to grow but was promptly killed, while the green aërobic streptococcus flourished.

CASE VI.—The sixth case was a private patient of Dr. M. R. Robinson's at the Beth Israel Hospital. One year before, a hysterectomy had been done in the Unity Hospital by Dr. A. Adnopoz. The wound had become infected and the drainage site gradually became a chronically draining sinus. Various antiseptics were used without avail. Gradually it began to undermine and spread. Several attempts were made to halt the infection by conservative excisions. It became worse and worse. Finally a secondary closure was attempted, but it broke down. When I showed an interest in the case, Doctor Robinson kindly offered to transfer her to our wards. This was done (J.F., Unit History No. 397938). The appearance of the wound at that time is shown in Fig. 13. The undermining extended down into the vulva and out in the flanks. Bacteriological examination again revealed the micro-aërophilic hæmolytic streptococcus. In this case, however, there were a few colonies of *Staphylococcus aureus* and a few hæmolytic streptococcus colonies grew on the aërobic plate. The anaërobic plate, however, was profusely covered with hæmolytic streptococcus colonies. The aërobic hæmolytic streptococcus colonies, therefore, either represented a contamination with an ordinary hæmolytic streptococcus or a few of the micro-aërophilic individuals had already adapted them-

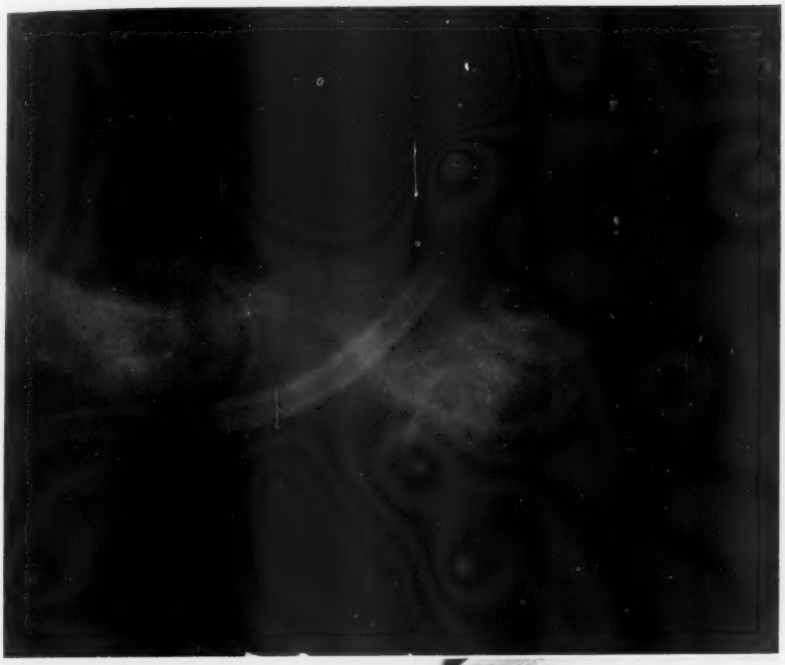


FIG. 11.—(Case V.) The superficial wound and the sinus leading into the pelvis had healed but this X ray film revealed a mass of fragmented zinc peroxide in the pelvis. A tube in the rectum indicated that the mass of residual zinc oxide was posterior to it in the hollow of the sacrum. This was removed by a posterior incision.

FIG. 12.—(Case V.) Wound practically healed.

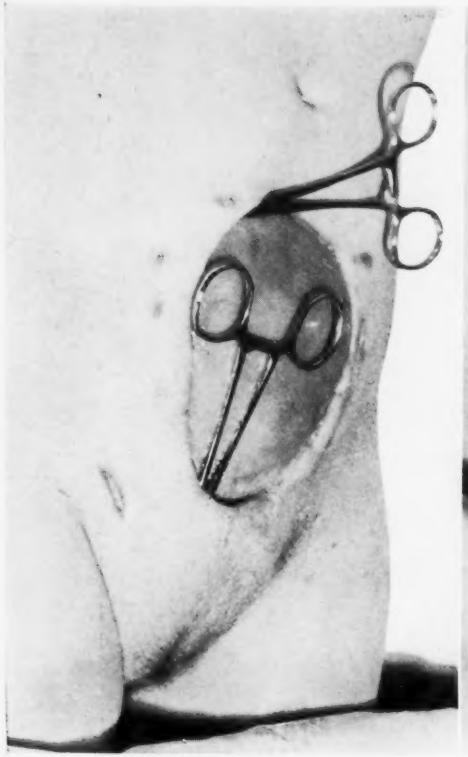


FIG. 13.—(Case VI.) On admission. One year after onset of illness. Note the extensive undermining extending into the vulva and into the flanks. The skin edges were rolled in. Counter incisions had been made in the groins.

FIG. 14.—(Case VI.) Three weeks after admission and four days after skin graft. Flecks of zinc peroxide may be seen on the wound surface. The rolled-in margins were trimmed away at the time the grafts were placed.

FIG. 15.—(Case VI.) Eleven weeks after admission, two weeks after discharge from the hospital. Wound well healed.

selves to the aërobic conditions on the surface of the wound. The wound was treated at once with a suspension of zinc peroxide, this time in a 5 per cent. pyrophosphate solution which suspends the heavy powder even better than gelatine and does not favor the growth of other organisms. Very promptly the fever subsided, the patient felt better, and the wound began to heal. The re-entrant angles slowly but progressively closed and the skin became adherent. The rolled-in margins were trimmed off and soon it was possible to plant some skin grafts in the centre to test their ability to survive in the presence of the exudate. They grew nicely and soon fused (Fig. 14). A little later the whole surface was covered with grafts and the wound promptly healed (Fig. 15).

Three days after the first application of zinc peroxide, cultures were made from the wound, and exactly as in the preceding case the micro-aërophilic hæmolytic streptococcus was no longer found, but in its place there was a green aërobic streptococcus. This coincidence with Case V seemed to confirm our theory that the original organism had become changed or dissociated in the wound following the use of zinc peroxide.

Discussion.—From these brief case abstracts a composite picture of this clinical entity may be drawn which may be outlined as follows. The disease begins gradually. What appears to be an ordinary drainage tract from a deep or subcutaneous abscess fails to follow the usual course of healing. Improvement which may have been present in the early stages of the infection gradually ceases. The skin margins become undermined with liquefaction of the subcutaneous fat and connective tissue. There is no gangrene of the skin, but the edges roll in. The undermining progresses and the skin opening widens, exposing a base of gelatinous, pale granulation tissue. In one or more places, in the neighborhood of the lesion, the skin may take on a dull red, or bluish appearance. It is then found that the undermining has extended beneath this area and the skin has become thinned out as if it were being liquefied from beneath. After a number of weeks a small opening appears in this thin area. This secondary opening gradually enlarges, and the margin may extend until it fuses with the original ulcer. In lower abdominal lesions the undermining frequently spreads down toward the groin or toward the pubic region, extending into the vulva, or into the scrotum, or beneath the crease of the groin into the thigh. In these regions it may extend inward, dissecting beneath the muscles and forming deep sinuses into the pelvis. In certain places where the skin is more firmly attached to the deep tissues, such as around the umbilicus or the crest of the ilium, the undermining may stop. In fact, there may be other areas around the margin where undermining does not take place, and in such regions healing may proceed with a new growth of skin. However, instead of progressing steadily, the margin of the new epithelium may become clear-cut and remain stationary for a long period of time or rapidly melt away. The lesion may show slight improvement from day to day over a period of several weeks, and then suddenly, within a period of a few days, all the benefit so slowly gained may be lost and the disease may extend more rapidly than ever.

The lesion is usually only moderately painful but the pain may be excruciating. Fever develops daily with temperature rises to 101° and 103°. During the course of the infection the temperature may run at a lower level for

Blanks. The skin edges were rolled in. Counter away at the time the grafts were placed.
Incisions had been made in the groins.

a period of days and then gradually rise to a higher level for a short time. During the period of fever the patient is usually greatly prostrated. In the course of time the lack of response to treatment brings great discouragement and gradually breaks down the patient's morale. This may reach such a degree that the patient expresses a desire to commit suicide. After months or years of suppuration the lesion may gradually heal spontaneously, or burrow deeply and produce death either by erosion into a large vessel, or by the gradual development of amyloid degeneration of the liver, spleen and kidneys. In reviewing the literature the author has not been able to find an adequate description of this disease.

The essential organism in this infection is probably a hæmolytic streptococcus which prefers an anaërobic environment. Its immediate source is probably either the intestinal tract or the vagina. In four of the six cases it could be obtained only by anaërobic cultivation and in two of these it was present in pure culture. But in two of the long-standing cases it was found with aërobic cultivation. However, even when it was obtained aërobically it was found to grow very much better anaërobically. After artificial cultivation on meat medium, it gradually takes on aërobic properties, and after a few generations it will grow on the aërobic plate. The colonies are small and gray and are surrounded by a clear hæmolytic zone with a diameter two or three times the size of the colony. It shows the usual cultural characteristics of Beta hæmolytic streptococci and it may have been originally an ordinary aërobe which has adapted itself to the anaërobic environment of the intestinal tract. The biochemical and serological reactions of these organisms will be reported later.

Colebrook[6] may have cultured such an organism from certain of his cases of puerperal fever but if so, he did not distinguish it from other hæmolytic streptococci. Smith[7] probably found it occasionally in certain cases of lung abscess. Thompson[8] did not happen to encounter an organism of this character in his study of "The Rôle of the Streptococci in Skin Diseases." Williams[9] did not mention such an organism in her book on pathogenic streptococci. Schottmüller[10] did not find it associated with his cases of puerperal fever. He was more interested in a strict anaërobe which was not hæmolytic and which produced a putrid gas in artificial media as well as in the lesion. The organism which we have found undoubtedly belongs to the group of "anaërobes by predilection" of Prèvot[11] although he did not describe any hæmolytic varieties. When such infections have been seen and only aërobic cultures have been taken, this organism has undoubtedly frequently been missed. When it has been recovered from the surface of the lesion by aërobic cultivation it has probably not been distinguished from the ordinary hæmolytic streptococcus. It can be properly identified only by cultivation both anaërobically and aërobically on blood-plates and by a comparison of the growth as it appears on those plates. We prefer the term "Micro-aërophilic."

With the organisms cultured from the last two cases we have attempted

to bring about the same change in the test tube which apparently occurred in the lesion, but so far the zinc peroxide has killed the micro-aërophilic hæmolytic streptococcus so readily in ordinary media that we have met with no real success. When ZnO_2 is added to a broth culture containing cooked meat (which gives a peroxidase reaction) the micro-aërophilic hæmolytic streptococcus may survive six or seven days but it finally succumbs. If during this time subcultures are made, an occasional green aërobic colony forms, but when it is subcultured it either grows anaërobically or reverts to the hæmolytic form.

It may be remembered that certain of the strains of hæmolytic streptococci which we cultured from patients, doctors and nurses in the Sloane Hospital epidemic of puerperal fever in 1927 changed into green streptococci after storage in meat media in the ice box for a number of months and yet they retained certain antigenic properties, for when they were injected into rabbits they produced agglutinating sera and they completely cross-absorbed agglutinin from sera produced by other hæmolytic strains in the same series. The mechanism of that change was not determined.[12]

Similarly, the mechanism of the change of the micro-aërophilic hæmolytic streptococcus into the aërobic green streptococcus in the lesions in Cases V and VI has not been determined but it would seem to have something to do with the ZnO_2.

This phenomenon seems to have a wider application than we have given it so far. During the past year we have experimented with the action of ZnO_2 on other micro-aërophilic non-hæmolytic streptococci and on certain of the strict anaërobes including *C.welchii*, and we have found that these organisms are all killed by the ZnO_2 in plain or 1 per cent. dextrose broth. In meat medium its lethal action is always delayed. Certain aërobic hæmolytic streptococci are also inhibited in their growth while it has no effect on the staphylococci, aërobic green streptococci or *B.coli* which we have tested so far. This difference may depend upon whether the organism is capable of forming peroxidase or not. We shall follow this further. Similarly, following the use of ZnO_2 in wounds from which anaërobic and other micro-aërophilic organisms have been cultured, in two or three days we have invariably failed to find these organisms either on smear or culture, except for one fatal case of *C.tetani* and *C.welchii* infection in which treatment had been employed only twenty-four hours. We have thus treated satisfactorily a case of gas gangrene of the thigh due to *C.welchii*, infection of the hand with *C.welchii*, infection of the buttock with *C.welchii*, amputation of the thigh for gangrene of the leg with *C.welchii* and *B.proteus*; chronic osteomyelitis with staphylococcus and the spirochætes and fusiform bacilli of Plaut-Vincent;[13, 14] several neck abscesses following dental infections with the Plaut-Vincent organisms; two cases of skin gangrene with a non-hæmolytic micro-aërophilic streptococcus and several cases with foul-smelling infections around the anus. In all of these cases there has been no evidence of irritation of the tissues by the zinc peroxide. Granulations have not been inhibited. Healing has apparently been favored and foul odors have disappeared. The

success so far obtained in the types above noted certainly encourages us to give it wider use in anaërobic and micro-aërophilic infections and dental infections. The possibility of prophylactic use in dentistry must also be considered. We shall try to explain the mechanism of its action by laboratory experimentation.

CONCLUSIONS

We have presented brief abstracts of the clinical course of six cases of chronic infection of the abdominal wall, characterized by a slowly developing ulceration without gangrene but with extensive undermining of the skin by the liquefaction of the subcutaneous tissue and the formation of the deep sinuses.

Apparently the essential causative organism in these infections was a micro-aërophilic hæmolytic streptococcus, preferring anaërobic environment and in most cases only found by anaërobic methods of cultivation.

In the last three cases the use of zinc peroxide favorably changed the course of the disease and was followed by relatively rapid resolution of the process.

In the last two cases, following the use of zinc peroxide, the organisms apparently underwent a striking change, losing both their hæmolytic and their anaërobic properties.

In the laboratory culture media, the micro-aërophilic hæmolytic streptococci from these cases were rapidly killed when zinc peroxide was added while their aërobic, non-hæmolytic progeny grew luxuriantly.

Zinc peroxide has been found to inhibit the growth and kill other micro-aërophilic and anaërobic organisms both in the test-tube and in infected wounds consistently enough to permit us to advise its use more extensively in these infections.

In searching the literature the author has not been able to find an adequate description of the clinical course or the bacteriological findings of this disease and we must assume that it is relatively rare but its chronicity and its severity are indicative of its importance.

This disease must not be confused with the acute gangrene of the skin as represented by hæmolytic streptococcus gangrene or with the chronic progressive post-operative gangrene of the synergistic type. It may be easily differentiated from these both clinically and bacteriologically if careful consideration is given to the characteristic features of these diseases.[15, 16, 1, 4, 5]

REFERENCES

[1] Brewer, G. E., and Meleney, F. L.: Progressive Gangrenous Infection of the Skin and Subcutaneous Tissues Following Operation for Acute Perforated Appendicitis: A Study in Symbiosis. ANNALS OF SURGERY, vol. 84, pp. 438–450, 1926.

[2] Meleney, F. L., Humphreys, F. B., and Carp, L.: An Unusual Fatal Operative Wound Infection Yielding a Pathogenic Anaërobe of the Gas Gangrene Group Not Hitherto Described. Sug., Gynec., and Obst., vol. 45, pp. 775–789, 1927.

[3] Meleney, F. L., Harvey, H. D., and Jern, H. Z.: Peritonitis I: The Correlation of the Bacteriology of the Peritoneal Exudate and the Clinical Course of the Disease. Arch. Surg., vol. 22, pp. 1–66, 1931.

[4] Meleney, F. L.: Bacterial Synergism in Disease Processes with a Confirmation of the Synergistic Bacterial Etiology of a Certain Type of Progressive Gangrene of the Abdominal Wall. Annals of Surgery, vol. 94, pp. 961–981, 1931.

[5] Meleney, F. L.: A Differential Diagnosis between Certain Types of Infectious Gangrene of the Skin. Sug., Gynec., and Obst., vol. 56, pp. 847–867, 1933.

[6] Colebrook, L.: Infection by Anaërobic Streptococci in Puerperal Fever. British Med. Jour., vol. 2, pp. 134–137, 1930.

[7] Smith, D. T.: Fusospirochaetal Disease. Williams and Wilkins, Baltimore, 8°, 243 pages, 1932; and personal communication.

[8] Thompson, D., and Thompson, R.: The Pathogenic Streptococci—the Rôle of Streptococci in Skin Diseases. Monograph XIII. Annals of the Pickett-Thompson Research Laboratory, vol. 7, 1931; and personal communication.

[9] Williams, A. W.: Streptococci in Relation to Man in Health and Disease. Williams and Wilkins, Baltimore, 8°, 260 pages, 1932.

[10] Schottmüller, H.: Zur Bedeutung einiger anaëroben in der pathologie insbesondere bei puerperalen Erkrankungen. Mitteil. aus den Grenz. der Med. u. Chir., vol. 21, pp. 450–490, 1910.

[11] Prèvot, A. R.: Les streptocoques anaerobies. Ann. de l'Inst. Pasteur, vol. 39, pp. 417–447, 1925.

[12] Meleney, F. L., Zau, Z. D., Zaytzeff, H., and Harvey, H. D.: Epidemiologic and Bacteriologic Investigation of the Sloane Hospital Epidemic of Hemolytic Streptococcus Puerperal Fever in 1927. Amer. Jour. of Obst. and Gynec., vol. 16, pp. 180–199, 1928.

[13] Plaut, H. C.: Le bacille fusiforme et le Spirillum sputigenum dans les angines ulcereuses. Compt. rend. Soc. de Biol., vol. 58, pp. 805–807, 1905.

[14] Vincent, H.: Sur la morphologie du bacille fusiforme. Response a M. Plaut. Compt. rend. Soc. de biol., vol. 58, pp. 805–807, 1905.

[15] Meleney, F. L.: Hemolytic Streptococcus Gangrene. Arch. Surg., vol. 9, pp. 317–364, 1924.

[16] Meleney, F. L.: Hemolytic Streptococcus Gangrene; the Importance of Early Diagnosis and Early Operation. J.A.M.A., vol. 92, pp. 2009–2012, 1929.

PARATHYROIDECTOMY FOR RAYNAUD'S DISEASE AND SCLERODERMA*

A PRELIMINARY REPORT

By Alice R. Bernheim, M.D., and John H. Garlock, M.D.

of New York, N. Y.

FROM THE DEPARTMENT OF SURGERY, CORNELL UNIVERSITY MEDICAL SCHOOL AND THE NEW YORK HOSPITAL

As a result of observations which now cover a number of years and which will be reported in detail in a subsequent communication, we have formed the opinion that disturbances in calcium metabolism are factors in the development of Raynaud's disease and other vasospastic conditions. Calcium deficiency in the diet, common in adults and producing a negative calcium balance, may cause in certain individuals an abnormal sensitiveness to vasospasm. In patients with thrombo-angiitis obliterans, Raynaud's disease or arteriosclerosis, vasoconstricting stimuli as cold, worry, fatigue, overexertion and tobacco may produce pain, undue coldness, intermittent claudication and discoloration of the extremities.

Exactly how disturbances in calcium metabolism produce the various manifestations seen in vasospastic conditions is not altogether clear. It is suggested that, inasmuch as calcium affects the permeability of every cell in the body, the results of insufficient calcium intake may be exceedingly varied. It is suggested further that the constitutional factor is of great importance in determining the reaction of different individuals to disturbances of calcium metabolism and therefore to the development of different clinical manifestations. The constitutional factor may be considered to depend upon a local inferiority which renders tissues more susceptible to damage, such as that produced by diminished blood supply through vasospasm. Thus, the symptoms presented by one patient may be solely dependent upon vasospasm of the peripheral vessels and, clinically, such a patient will present all the phenomena characteristic of Raynaud's disease. Another may show evidences of scleroderma, more or less generalized, or confined to the hands and feet (sclerodactylia). We have noted that nearly all of the scleroderma patients have, associated with the skin changes, varying degrees of vasospasm of the peripheral vessels producing manifestations similar to those of Raynaud's disease. Another group of patients will present symptoms of recurrent nephrolithiasis or nephrocalcinosis, due to excessive calcium excretion through the kidneys. These may or may not be associated with bone changes. Again, the changes may be confined to the bony skeleton, producing generalized decalcification. Finally, the same theoretical considerations may be extended

* Read before the New York Surgical Society, October 10, 1934.

to include the subject of arteriosclerosis: we are aware of the fact that disturbances of lipoid metabolism may be a large factor here; still, we believe that vasospasm plays an important rôle in the causation of symptoms in peripheral arteriosclerosis.

To understand the rationale for parathyroidectomy in these conditions, one must start with the important assumption that one of the functions of the parathyroid glands is to maintain a constant serum calcium level of about 10 to 10.5 milligrams per 100 cubic centimetres. With long deficiency in calcium intake the stores of body calcium become exhausted, and the parathyroid glands become hyperplastic, apparently because of their increased physiological activity in withdrawing calcium from depleted bones, and possibly also from other tissues. This, then, may be regarded as a work hypertrophy of the parathyroid glands. The constitutional factor becomes a part of the picture, and eventually various clinical symptoms are manifested which bring the patient to the physician. Whether the form of calcium drawn from the bones is a different variety from that supplied through an adequate diet is still a matter of conjecture.

If such patients are given an adequate calcium regimen, many of them will respond favorably. That is, there will be a marked amelioration of symptoms which have been due primarily to vasospasm. This has been our experience in many cases of Raynaud's disease, thrombo-angiitis obliterans, and arteriosclerosis. It is our conception that, in such cases, following adequate treatment with calcium, the parathyroids are relieved of their extra work of drawing calcium from the bone reserve, and may soon return to a normal physiological state. However, in certain instances, improvement does not take place in spite of prolonged treatment. We feel that, in these patients, a change of a more or less permanent nature has taken place in the parathyroids, resulting in hyperplasia or disturbed function, and that in such instances removal of two or more parathyroid bodies is indicated.

Up to the present time, six patients, who were not improved by the conservative therapy already mentioned, have been subjected to parathyroidectomy. Three cases presented generalized scleroderma with moderately severe Raynaud's manifestations in the hands and feet. One patient showed advanced sclerodactylia with symptoms of vasospasm of the hands and feet. Two patients presented the picture of Raynaud's disease uncomplicated by skin changes. Following operation, a dramatic relief of symptoms due to vasospasm was noted in each instance. The relief of pain and the change in color of the involved extremities to normal occurred practically within twenty-four hours. The most astonishing results were noted in the cases of uncomplicated Raynaud's disease. The fingers of these patients, which were deeply purple before operation, regained their normal color within twenty-four hours, and did not change again even after immersion in ice water. Rapid improvement was noted in the oscillometric determinations both as to range of oscillation and degree of spasm. Improvement in surface tem-

perature was also evident. Up to the present, after a lapse of three months to a year, these patients have continued to do well.

Our observations of the patients with scleroderma disclosed some interesting facts. Our first patient presented such extensive involvement that he was unable to open his mouth sufficiently to chew solid food and had great difficulty in using his fingers. Since operation, he has been able to open his mouth widely and can now eat normally. His finger mobility has improved sufficiently to permit him to resume his occupation as a book-dealer. Permanent changes have probably taken place in the capsules of the finger joints as a result of the prolonged flexed position and prevent further improvement. We have noted that the patients with scleroderma continue to improve up to a certain point and then remain stationary. The involved skin becomes noticeably softer, wrinkles return, and finger function improves. Some patients present greater improvement than others.

In the first three cases, two parathyroid glands were removed. In the last three cases, we performed total excision of two glands, and subtotal removal of a third, after isolation of all four parathyroids. In every case, the glands presented hypertrophy of varying degrees. Those showing the greatest enlargement were removed. Microscopically, the excised glands showed varying pictures. The gland removed from the case with extensive scleroderma presented an acute parathyroiditis with pronounced infiltration of polymorphonuclear leucocytes. Those of the cases of uncomplicated Raynaud's disease showed marked hyperplasia. Those of the remaining cases failed to show any abnormalities.

The technical aspects of the operative procedure present problems of considerable importance and will form the basis of a subsequent report by one of us (J. H. G.). We believe that it is important to isolate all four parathyroid glands and to exclude the presence of an adenoma before removal of any gland. This requires a good light, free exposure, meticulous hæmostasis, an atraumatic technic, and a thorough knowledge of the usual positions of the parathyroids and all their anatomical variations. The surgeon must avoid the casting of light shadows in order to bring out the differences in color of the yellow of fat, the reddish-brown of thyroid gland, and the peculiar light brown of the parathyroids. These differences in color offer the most reliable clue to the rapid location of the glands.

DISCUSSION

The argument may be advanced that, because the integrity of glands of internal secretion is protected by a large margin of safety, a rapid return to the previous state will result from an hypertrophy of the remaining parathyroids. We can only answer this criticism by stating that the contrary has been our experience in the cases so treated, provided that, post-operatively, an adequate calcium intake is maintained. We offer the following explanation of this experience: The removal of two or more parathyroid glands breaks a vicious circle which curtails parathyroid activity by fifty

per cent. or more. Before a compensatory hypertrophy of the remaining glands can take place, an high calcium intake relieves these glands of their overwork in drawing calcium from an exhausted supply in the bones, and restores the calcium balance to a relatively normal state. In other words, from the standpoint of calcium metabolism, the patient is, after parathyroidectomy, in the same situation as he was before the development of his symptoms. It is obvious that the high calcium regimen should be continued indefinitely. It may also be true that, following the removal of two or more parathyroids, a temporary relative hypoparathyroidism is produced, and that subsequently, while compensatory hypertrophy of the remaining parathyroids is taking place, an adequate calcium regimen restores the patient to a normal calcium balance.

It is significant that none of the cases here described developed symptoms of tetany, in spite of the fact that, post-operatively, only insignificant doses of parathormone and calcium were administered. We believe that the adequate pre-operative preparation by means of a high calcium intake, is an important factor in the prevention of post-operative tetany. In the case reports of Aub, Allbright, and Bauer, no mention is made of any pre-operative calcium preparation, and this may explain the high incidence of post-operative tetany in their patients.

We agree with Churchill and Cope that a diagnosis of hyperparathyroidism cannot be made on a single determination of the serum calcium and phosphorus. It is imperative for accurate interpretation that all blood determinations be made on fasting blood levels. Whether it is necessary to subject all patients to the laborious metabolic studies involving careful estimations of intake, and urinary and fecal output, is a debatable question. We are inclined to agree with the statement of Allbright, Aub, and Bauer: "Whereas hypercalcinuria and hyperphosphaturia are two of the most constant metabolic abnormalities of hyperparathyroidism, from a practical clinical point of view, this evidence is extremely laborious to obtain, seldom necessary and, in border-line cases, often not helpful. Thus, hypercalcinuria is dependent on the hypercalcæmia. If the latter is at a border-line level, the former will be as well."

We do not agree with the statement of Churchill and Cope that hypercalcæmia and hypophosphatæmia be present before surgical attack on the parathyroids is considered. It is our opinion that such an attitude narrows the field of our conception of parathyroid physiology to the confines of von Recklinghausen's disease of bone. We feel that there are many aspects of the subject involving a broader viewpoint and that, at the present time, we are only scratching the surface of an enormously interesting and complicated problem.

It is our belief that this view that disturbed calcium metabolism is the underlying factor of vasospasm in peripheral vascular disease, has not been advanced before. It is only during the past two years that our attention has been centred on the parathyroid glands in those cases which were re-

sistant to conservative therapy. Parathyroidectomy for scleroderma had been done before (Leriche, Ballin, and Oppel), but the interpretation of the reasons for this procedure as herein outlined, has not, we believe, been previously recorded.

Significant experimental confirmation of the rationale of parathyroidectomy for scleroderma is suggested by our duplication of the work of Selye. If parathormone is injected intraperitoneally in young rats, a skin lesion develops which closely resembles the sclerodermatous process found in humans. Selye noted this finding while trying to produce osteitis fibrosa cystica experimentally by the repeated injections of parathormone.

We feel that parathyroidectomy for Raynaud's disease, and other vasospastic conditions, opens up an entirely new aspect in the treatment of these disturbances. The promising and suggestive results obtained in the cases described below lead us to believe that another link is being developed in the chain of evidence of the great importance of the glands of internal secretion in the body economy. The recently published evidence of the existence of a parathyrotropic substance in the pituitary gland is suggestive confirmation of some of the views expressed in this paper.

CASE REPORTS

CASE I.—F. L., a man of fifty-three years was first seen on March 20, 1933. He stated that fourteen months earlier he had noticed that his fingers were gradually becoming stiff, and that the skin began to assume a thickened and discolored appearance. At about the same time, the toes developed stiffness and discoloration. Since the onset, the skin over most of the body had gradually become stiffer, dry, and discolored. The condition, apparently, was most pronounced over the forearms, arms, and hands. Because of this stiffness and hardening of the skin, the patient had developed marked impairment of motion in the various joints of the fingers and wrist, with the production of a severe flexion contracture of all the fingers. The patient had noticed increasing inability to chew solid food, because he was unable to open his mouth to masticate properly. Immediately before the development of the skin thickening, he had noted that the fingers became white when the temperature changed.

Inquiry into his past history elicited the fact that the patient had been on a low calcium diet for most of his life. There was a definite history of exposure to arsenic. The patient smoked on the average of ten cigarettes a day.

Examination showed a severe generalized scleroderma, most marked on the hands, forearms, arms and face. There was a peculiar yellowish-tan pigmentation of uneven distribution, confined mainly to the hands, forearms, and face. There was a well-pronounced circumoral pallor. The fingers of both hands were held in a markedly flexed position, and could not be extended. There was resultant impairment of motion in the interphalangeal joints. It was felt, at the time, that considerable change had taken place in the capsules of the various finger joints. General physical examination was negative. Temperature 37.8° C., pulse 110, respiration 22, blood-pressure 136/80, serum calcium 10.0 milligrams per 100 cubic centimetres, phosphorus 4.5 milligrams, phosphatase 5.2 (Bodansky units). The urine was examined for arsenic, and a positive test resulted. After seven intravenous injections of sodium thiosulphate, his urine became free of arsenic, but no improvement in symptoms followed. Oscillometric determinations revealed greatly diminished oscillations in both ankles and feet and in the wrists, with evidence of much spasm. There was a peculiar bluish mottling of the hands and feet which became more pronounced on immersion in cold water. The patient was

Fig. 1.—Microphotograph of a normal parathyroid gland. Low power magnification X 450. To be compared with Fig. 4. Note the regularity of the shape of the cells and the size of the nuclei and the abundance of intercellular stroma.

Fig. 2.—Microphotograph of normal parathyroid gland. High power magnification X 900. The regular distribution and size of the cells is to be noted.

Fig. 3.—Microphotograph of section of one of the parathyroid glands removed from patient No. 1. High power magnification X 900. The large number of polymorphonuclear leucocytes scattered through the stroma of the gland is evident.

placed on one form of high calcium regimen after another for a period of six months. During this time, although there was marked improvement in his general well-being, the scleroderma and Raynaud's symptoms became worse. Failure to respond to medical treatment led, after much consideration, to the decision of parathyroidectomy. The patient was, accordingly, admitted to the New York Hospital.

Laboratory findings revealed red blood-cells 5,040,000, hæmoglobin 87 per cent., white blood-cells 14,600, polymorphonuclear leucocytes 69 per cent., lymphocytes 18 per cent., monocytes 10 per cent., eosinophiles 2 per cent., basophiles 1 per cent., Kline test negative, blood sugar 75 milligrams, icterus index 8.8. Gastric analysis showed a total acidity of 12, and a free acidity of 5. X-ray of the skeleton for decalcification was negative. For a week before operation, the patient was placed on a high calcium regimen consisting of three meals a day which included one quart of milk, orange juice eight ounces, and tomato juice eight ounces. In addition to this diet, he was given calcium lactate, 40 grains two times a day (one hour before breakfast and one hour before supper), and three vitamin A and D tablets two times a day after meals. On the evening before operation, the patient was given 40 units of parathormone intramuscularly.

Operation was performed on October 20, 1933, under ethylene anæsthesia. The right superior parathyroid was situated beneath the border of the thyroid lobe opposite the cricoid cartilage. It measured three-sixteenths of an inch in length, and one-quarter of an inch in diameter. It was friable. The inferior parathyroid was found beneath the inferiod thyroid vein, on a level with the inner end of the clavicle. The left parathyroid glands were found in approximately the same situation, and appeared to be of about the same size. No adenoma was demonstrable. The right superior and inferior glands were removed and the wound was closed without drainage.

Microscopical examination (Fig. 3) of the parathyroids revealed a large number of polymorphonuclear leucocytes scattered about in the interstitial tissue. The glandular cells were arranged in tubular formation for the most part, and were predominantly of the "clear or principal type." The oxyphilic cells were infrequent, and many of them were degenerated. There was evidence of orange-colored globules which probably represented colloid material. Doctor Chandler Foote reported acute parathyroiditis with possible oxyphilic degeneration.

Within twenty-four hours after the operation, the bluish mottling which had been present completely disappeared. The numbness which the patient had complained of also gradually disappeared. The post-operative convalescence was extremely smooth, and at no time was there any evidence of tetany. The high calcium and high vitamin regimen which had been instituted, was maintained post-operatively, and continues to date. During the following two or three months, the patient noted that there was a marked improvement in the mobility of the various fingers, that he could use his hands for duties which he was unable to perform before, that he was able to open his mouth further, and could now chew solid food without difficulty, and that his face which previously had presented a masked appearance again showed numerous wrinkles which had been noted before the onset of his illness. This improvement in the condition of the skin continued for a period of about five months. Since then, the scleroderma has remained stationary. The symptoms, due primarily to vasospasm, have almost completely disappeared. The patient has returned to work as a book salesman, and is now able to support himself.

Case II.—The authors are indebted to Dr. William DeW. Andrus for permission to report this case. It is that of a patient at the New York Hospital who was operated upon by him.

A. G., a woman of thirty-two years, mother of four children, was admitted to the wards of the New York Hospital on April 27, 1934, with the following history: For the past four years, she had noted development of decided cyanosis of the fingers and toes, more marked in cold weather and when the hands were immersed in cold water,

All her symptoms had become more aggravated after the birth of her last child, six months previously. She stated that in cold weather especially, the hands would become dead white, later red, and then blue. This change in color was always accompanied by severe pain in the hands with a feeling of numbness and heaviness. Immersion in warm water brought immediate relief. When her hands were removed from warm water, the pain would return. For the past few months, she had had difficult situations at home to cope with, and this had seemed to aggravate her symptoms. For several days before her admission to the hospital her fingers, regardless of the external temperature, had been deeply and constantly cyanosed. Careful inquiry into her past history indicated that she had been calcium starved for most of her life. She had had pneumonia six years before, and had undergone a right salpingo-oöphorectomy for ectopic gestation in 1921. This patient presented numerous other complaints, as did nearly all of those reported in this paper, namely, lassitude, weakness, tiring on exertion, and frequent colds, dizziness, shortness of breath, and vague gastro-intestinal symptoms.

Physical examination showed a thin dark woman who looked about ten years older than her given age. Lips were cyanotic; eyes, ears, nose, and mouth, were negative. The neck presented no palpable mass. Heart and lungs were negative. The abdomen presented a diastasis of the recti muscles with a ptosis of the liver and kidneys. The hands at the original examination were warm, red in color, and covered with perspiration. The flush was noted to increase up to the finger tips. Radial pulsation seemed equal and normal. The feet appeared normal. The dorsalis pedis pulse and popliteal vessels were easily palpable. The remainder of the examination was negative. Temperature 37.6° C., pulse 80, respiration 20, blood-pressure 128/68. Oscillometric readings at the ankle, foot, wrist, and arm, were slightly below the normal variation. The ice water test with immersion of both hands and both feet revealed the typical response of Raynaud's disease. Serum calcium 11.4 milligrams per 100 cubic centimetres, phosphorus 4.9. Urine was negative. Hæmoglobin 95 per cent., red blood-cells 5,200,000, white blood-cells 12,600, polymorphonuclear leucocytes 70 per cent.

It had originally been intended to perform a ganglionectomy on this patient. However, after considerable discussion, it was decided to try parathyroidectomy instead. Accordingly, following the administration of a high calcium regimen as indicated in Case I, the patient was operated upon under local anæsthesia. Doctor Andrus isolated the right superior parathyroid gland which was situated directly behind the middle thyroid vein. It was 1.0 centimetres in diameter. On the left side, the inferior parathyroid gland was demonstrated, and was found to be of about the same size. Both glands were removed. A careful search was made for an adenoma, but none was found. A verbatim report of the pathologist's findings on microscopical examination is herewith appended. (Fig. 4a and b.)

"Sections from the parathyroid gland show it to be somewhat enlarged, with a normal amount of fatty tissue scattered diffusely throughout the gland. At the periphery are several acini, lined by low columnar epithelium and filled by a granular exudate which does not appear to be colloid, as seen in the thyroid gland. In places, the tissue appears to be normal parathyroid gland, made up of cells with an indefinite cell outline and round nuclei with a very slight tendency to form acini. In these areas very few eosinophilic cells are to be found. In other portions of this gland there is an entirely different picture. The cells are elongated, oval, with dark cytoplasm and oval, dark-staining nuclei, which have no polarity and have absolutely no tendency to form acini, but group themselves about fatty tissue and the larger blood-vessels, as well as the capillaries. In these sections there are large numbers of eosinophilic cells. This picture is found in both parathyroid glands removed, although the gland removed from the right side of the neck is smaller than that removed from the left side. There seems to be only a normal number of polymorphonuclear leucocytes in the blood-vessels and none are seen scattered about in the tissues."

Post-operatively, the patient's convalescence was entirely uneventful. At no time

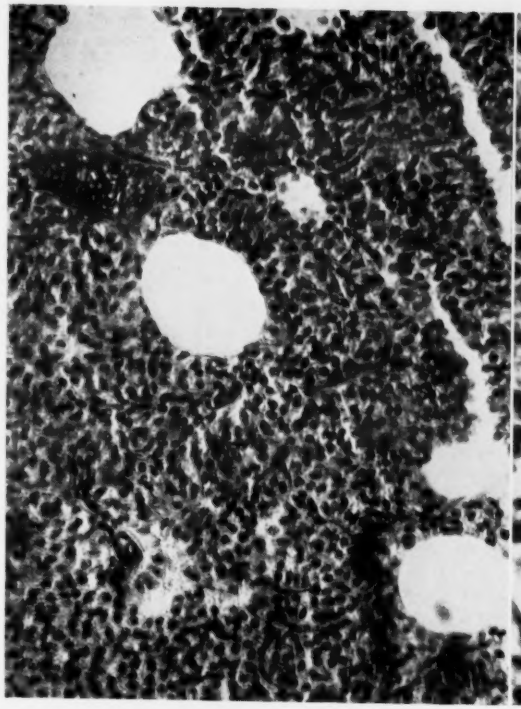


FIG. 4A.—Microphotograph of section of one of the parathyroids removed from patient with Raynaud's disease. Low power magnification X 450. A comparison with Fig. 1 will indicate that the cells in this specimen are larger, the nuclei are larger and more vesicular, and the cells are more closely packed, with a marked diminution in the intercellular stroma.

FIG. 4B.—Microphotograph of the same gland. High power magnification X 900. This is to be compared with Fig. 2.

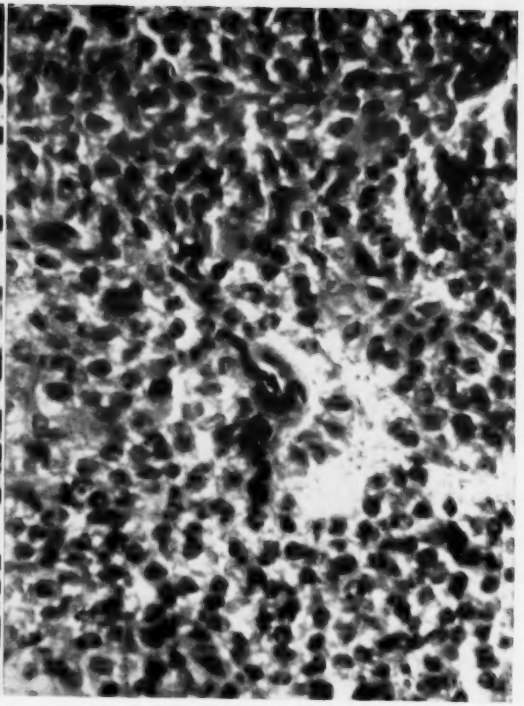


FIG. 5.—Microphotograph of one of the parathyroids removed from the sixth patient described in the text. High power magnification X 900. This is to be compared with Fig. 2. The cells are larger, the nuclei are more vesicular and the intercellular substance is rather diminished.

was there any evidence of tetany. Almost within twenty-four hours after operation, the skin of the hands and fingers became pink and warm, and showed an elevation of six degrees in the surface temperature. The patient was placed upon a high calcium regimen post-operatively, and this has been continued to date.

In spite of numerous emotional upsets due to family difficulties, the patient has felt well, and at no time has there been any return of the deep cyanosis and pain which were present before operation. The numerous vague symptoms described above have disappeared. The lassitude and fatigue which were prominent symptoms before operation have gradually abated. The patient has gained considerable weight.

CASE III.—H. R., a fifty-eight-year-old woman, was admitted to the Medical Service of the New York Hospital May 7, 1934, with the following history: She had been well until ten months ago when she developed swollen tender fingers, associated with pain which radiated from the fingers to the elbow. A few days later, a similar condition had involved the knee-joints. This had been followed by itching of the skin of the back from the neck to the buttocks. During the illness, the patient had noticed a gradual thickening of the skin of most of the body. In addition, there had developed a peculiar pigmentation involving the entire skin area. Previous to coming to the hospital, the patient had received extensive treatment at the hands of many dermatologists without improvement. The color changes in the hands and feet had become especially aggravated during cold weather.

Physical examination showed a well-developed and well-nourished woman whose skin was diffusely and unevenly pigmented, the color suggesting suntan. This pigmentation was deeper over the buttocks, and well marked also over the abdomen and back. This was in direct contrast to the legs which were not involved in the pigmentary changes. The skin was dry and somewhat thickened. The hair of the scalp and eyebrows was coarse, dry and thin. The axillary and pubic hair was very scant. The skin of the fingers and hands presented a typical picture of advanced sclerodactylia. In addition, the fingers and the dorsum of the hands presented a peculiar purplish mottling which became deeper in color in the dependent position, and after immersion in ice water. The feet presented the same picture although not so marked. Following immersion in cold water, considerable pain was produced in the hands and feet. All the peripheral vessels felt thickened. The rest of the examination was negative. Blood-pressure 110/70, temperature 37.6° C., respiration 20, urine negative, red blood-cells 3,500,000, hæmoglobin 90 per cent., white blood-cells, 7,000, polymorphonuclear leucocytes 71 per cent., lymphocytes 22 per cent., monocytes 7 per cent., Kline test negative, blood sugar 62 milligrams, serum chlorides 570, serum calcium 10.2 milligrams per 100 cubic centimeters, phosphorus 4.6, phosphatase 3.5 units, streptococcus agglutination test negative, basal metabolism minus 1 per cent., corrected sedimentation rate 1.35, red-blood-cell volume 43 per cent., glucose tolerance test negative. Calcium tolerance test showed an unusual elevation of the serum calcium after fifteen minutes without change in the phosphorus or phosphatase. Oscillometric determinations of the extremities revealed marked diminution in the oscillations at the calf, ankle, foot, arm, and wrist, with evidence of considerable spasm. The surface temperature determinations revealed decided lowering of the temperature of the hands and feet. X-ray examination of the skeleton was negative for osteoporosis.

This case presented the unusual picture of scleroderma with Raynaud's manifestations accompanied by pigmentation. This condition has been described in literature and has been mistaken for Addison's disease. A careful inquiry into the past history of this patient indicated an unusually marked calcium deficiency in her diet for many years. It was felt that the underlying basis for the picture presented in this patient was a disturbance of calcium metabolism, and the patient was therefore placed upon a high calcium regimen for a period of one month.

There was, however, no change in the patient's condition and parathyroidectomy was performed on June 22, 1934, after preliminary administration of parathormone. The right superior parathyroid was found outside the capsule of the thyroid gland surrounded

by fat, at the level of the cricoid cartilage. The right inferior gland was found partially embedded in the substance of the thyroid gland just above its lower pole on the posterior aspect. The left parathyroid glands were found in similar positions. Both superior glands were somewhat enlarged and measured approximately .5 centimetre in diameter.

The superior parathyroids were removed entirely and two-thirds of the left inferior parathyroid was excised. A careful search for an adenoma in the region of the œsophagus and behind the manubrium sterni revealed nothing of note.

A report of the pathological examination of the excised parathyroid glands follows: "The sections show parathyroid bodies with considerable hæmorrhage, which seems to be traumatic. Eosinophile cells are present, but not numerous, and on the outside of the gland there seems to be considerable fat. Small areas near the periphery show cells which suggest hyperplasia, in that the nuclei are darker and the cells grow closer together, without forming acinous structures. The blood-vessels found in this organ appear to contain more polymorphonuclear leucocytes than one would ordinarily expect to find."

Post-operatively, the high calcium regimen was continued, supplemented by injections of parathormone for two days. Convalescence was uneventful and the wound healed by primary union. The discoloration of the hands and feet practically disappeared. The skin assumed a pink appearance and felt warm to the touch. There was an elevation of three degrees in the skin temperature. Oscillometric readings were considerably increased. Since discharge from the hospital, many of the patient's complaints have abated, although she still complains of pain in both knees and has difficulty in getting about. The skin of the hands is slowly becoming softer, permitting more active use of the fingers than was evident before operation. It is too soon to tell whether further improvement will take place in the sclerodactylia.

Case IV.—M. M., a woman of thirty-three years, was first admitted to the Medical Service of the Mt. Sinai Hospital on November 10, 1933, complaining of blueness and coldness of the toes and fingers of ten years' duration. Since youth, this patient had always been intolerant of cold weather. She had developed pain and coldness of the fingers and toes during the cold months of the year. For the past ten years, she had had vasospastic symptoms typical of Raynaud's disease, involving the fingers and toes, and to a slight extent the ears and tip of the nose. There was almost complete relief of symptoms during warm weather, and upon immersion of the hands in warm water. During recent years, she had noted that the skin of the fingers was gradually becoming dry, firm, and shiny, cracking easily, and becoming infected. Within the past two years, she had noted that the skin of the face was becoming firm and hard, producing a drawn expression, and causing difficulty in complete closure of the mouth. The patient stated that she was nervous, and when she was easily upset, the color changes in the hands became more prominent. For one year, she had noted pain in the small joints of her hands, which, at times, would swell. With the gradual hardening of the skin of the hands and fingers, she had developed inability to flex the fingers completely.

For the past thirteen years, she had had symptoms suggestive of pulmonary tuberculosis, and had been treated for a long time in a tuberculosis clinic. At no time had the sputum been positive. In addition to the above symptoms, the patient had had for many years general bodily aches, lassitude, and vague gastro-intestinal symptoms.

Physical examination showed a chronically ill, thin woman appearing older than her given age. The skin of the face was hard and tight, producing a retraction of the upper lip which exposed the upper teeth. She was unable to close her mouth. All the peripheral pulses could be felt. There was no thickening of the vessels. The skin of the neck, antecubital fossæ, hands and feet, was involved in a moderately severe sclerodermal process. The toes and fingers presented a mottled blue color. The patient was unable to flex the fingers of both hands completely. There were physical signs suggestive of a tuberculosis of both upper lobes. Hæmoglobin 75 per cent., red blood-cells 4,290,000, color index 0.87, white blood-cells 11,800, polymorphonuclear leucocytes

60 per cent., lymphocytes 40 per cent., sedimentation time 1.36 minutes, urea nitrogen 11, blood sugar 85, calcium 10.4, phosphorus 4.5, phosphatase 1.9. Calcium tolerance test suggested a disturbance of calcium metabolism. Wassermann was negative, urine negative for arsenic. Sputum was repeatedly negative for tuberculosis. X-ray of chest showed a healing tuberculosis of both upper lobes. Oscillometric determinations showed a marked diminution in the oscillation of both arms, forearms, wrists, legs, and ankles. Surface temperature determinations were as follows: Body temperature 37° C.

Right			*Left*	*Control*
32½	Mid-forearm		32½	37
29	Fingers	1	29½	34½
29		2	28	34
29		3	28	34
28½		4	29	34
29½		5	29	34
32	Mid-leg			
25½	Toes	1	25	
25½		2	25	
25½		3	25	
25½		4	25	
26		5	25	

The patient was placed upon a high calcium regimen as indicated in the previous case reports, and discharged from the hospital. Inasmuch as there was no improvement in her condition, she was admitted again to the Mt. Sinai Hospital, Surgical Service of Dr. R. Lewisohn, on March 26, 1934. Following preliminary administration of parathormone and calcium gluconate for three days, parathyroidectomy was performed on April 5, 1934. The right superior and inferior parathyroid bodies were easily isolated. They were both enlarged, measuring 1 centimetre in diameter. The superior one was situated outside of the thyroid capsule opposite the thyroid cartilage. The inferior parathyroid was found at the lower pole of the thyroid gland posterior to the emergence of the inferior thyroid vein. The left inferior parathyroid gland was found in approximately the same situation. Because of infiltration of the tissues with blood, it was impossible to isolate the left superior parathyroid. Both right parathyroid glands were excised completely. Pathologically, they presented nothing of note.

On the evening of the day of operation, the patient developed a hæmorrhage into her wound due to the slipping of the ligature from the left superior thyroid artery. Because of signs of obstruction to breathing, the house surgeon performed a tracheotomy. The artery was isolated and ligated again, and the wound packed open. The tracheotomy tube was removed on the fifth post-operative day, and the wound soon healed without infection. Parathormone was given for forty-eight hours after operation. At no time during her convalescence did any symptoms of tetany develop. Within forty-eight hours after operation, the fingers and toes assumed a normal pink color, with a corresponding increase in surface temperature. Three days after operation, she was able to close both hands completely. On the sixth day after operation, blood calcium was 10.4, phosphorus 4. The patient was seen in the follow-up clinic at the beginning of August, 1934. At that time she stated that the pain in the hands and feet had disappeared. There had been no recurrence of the discoloration of the fingers and toes. Skin thickening was markedly improved, and she was now able to close her mouth completely. A striking improvement was noted in the vague gastro-intestinal and general complaints of lassitude and asthenia. The patient felt that she had been markedly improved by the operation.

Case V.—R. F., a woman of fifty years, was admitted to the Peripheral Vascular Clinic of the New York Hospital on June 8, 1934, complaining of numbness of the hands and feet of three years' duration, heart-burn and indigestion of one year's dura-

tion, and asthenia over a period of ten years. Her past history indicated that she had had lupus erythematosis in 1921, which had been cured. The present illness had begun about three years before, when she had noted that her hands and feet were numb and turned purple in cold weather. These symptoms had become progressive, and during the past summer the patient had been unable to obtain relief even in warm weather. Her gastro-intestinal symptoms consisted of heart-burn after eating, belching of gas, and occasional vomiting. She also stated that for many years she had felt tired most of the time, and to perform her usual activities had required considerable effort.

Examination showed a short, stocky woman with the scars of a healed lupus of the face and forehead. A small adenoma was felt in the right lobe of the thyroid gland. Heart and lungs were negative. The skin of the face, hands, feet, forearms and legs was markedly thickened and indurated. The fingers presented a peculiar mottled cyanosis extending to the back of the hands, with a definite lowering of the surface temperature. The feet presented the same condition. Oscillometric determinations showed a marked diminution of the oscillations at both ankles, feet and wrists. The peripheral pulses were palpable, with the exception of the right dorsalis pedis, which was just barely discernible. The cold water test of the hands and feet produced changes typical of Raynaud's disease. Urine was negative, red blood-cells 3,980,000, hæmoglobin 76 per cent., white blood-cells 7,800, polymorphonuclear leucocytes 61 per cent., Kline test negative, urea nitrogen 10, blood sugar 83, serum calcium 9.9, serum phosphorus 3.8, phosphatase 2.1 units. Calcium tolerance test indicated a disturbance of calcium metabolism. The patient was placed upon a high calcium regimen as already described, without any improvement in the symptoms. She was therefore considered a suitable case for parathyroidectomy, and was admitted to the New York Hospital on July 12, 1934.

After preliminary administration of parathormone and calglucon, parathyroidectomy was performed on July 18, 1934. Two adenomata were found in the right lobe of the thyroid gland. The presence of these masses made exposure and identification of the parathyroid glands on the right side difficult. Careful dissection revealed what was at first thought to be a markedly hypertrophied parathyroid gland just at the lower pole of the thyroid gland immediately above the entrance of the inferior vessels. An attempt to isolate the superior parathyroid gland was unsuccessful. The left side was then explored, and the left inferior parathyroid gland was found in about the same relative situation as the one on the right. The left superior gland was not found. There was no evidence of a parathyroid adenoma. Dissection of the enlarged right inferior gland revealed that this mass was composed of the two parathyroid glands, superior and inferior, which were intimately connected. The identified glands were larger than normal. The left lower and right superior parathyroid glands were removed completely, and about two-thirds of the right lower gland was excised. The right lobe of the thyroid gland was then subtotally resected, removing the adenomata, and the wound was closed without drainage. Pathological examination of the removed glands is herewith reported:

"The sections of the specimen reveal parathyroid tissue which is heavily invaded by fatty tissue. This fatty tissue shows areas of degeneration. The amount of parathyroid tissue is markedly diminished. There are also regions which show hæmorrhage. The cells of the parathyroid are almost uniformly hyperchromatic. They are circular or oval in shape and the cytoplasm is light-staining and granular. There is considerable metaplasia of the cells of the gland."

The patient's convalescence post-operatively was entirely uneventful. At no time was there any sign of tetany. Parathormone was administered for three days. On July 25, 1934, the cold water test of the hands and feet showed the slightest suggestion of blueness of the finger tips. No change was noted in the toes. The patient has continued to improve since discharge from the hospital, and can now immerse her hands in cold water without the development of numbness or change in color. The lassitude which was a prominent complaint before operation is rapidly disappearing.

CASE VI.—E. A., a married woman of thirty-four years, was referred by Dr. Harry Fialk, complaining of pain in the hands and legs of nine years' duration. Since childhood, this patient had suffered from chilblains, and had been extremely susceptible to cold weather. Nine years ago, following childbirth, she had developed pain in the toes of her left foot. This pain had gradually involved the left leg. As time went on, pain had been felt in the right leg. Soon after onset, the pain had been worse in cold weather, and had been accompanied by color changes in the toes and feet. The skin would become dead white, finally cyanotic, and then red. Four years previously, she had developed similar symptoms in the hands. About the same time, she had developed symptoms which strongly suggested coronary artery disease, namely, anginal attacks with precordial pain and a sense of substernal oppression radiating to both shoulders. She had been admitted to the Jersey City Hospital where she had been studied for three months. About three years ago, the pain in the legs had been accompanied by swelling of the feet and ankles. During this time she had lost considerable weight. The past history was negative except for an attack of rheumatic fever at the age of seventeen years. Careful inquiry elicited the fact that she had been on a low calcium intake most of her life. During these nine years, she had been studied by many physicians, and had had many types of treatment without relief.

Physical examination showed a thin, undernourished woman of thirty-four years. Head, neck, chest, and abdomen were negative. Blood-pressure was 120/60, pulse 90, respiration 20, temperature 37.4° C. Pelvic and rectal examinations were negative. Both hands and feet were considerably colder than the rest of the body. There was no clubbing of the fingers or toes, and there were no varicosities. When the patient hung her legs over the bed for a period of ten minutes, the feet became reddish purple in color, and finally took on a dusky blue tinge. Immersion of the hands and feet in cold water produced the phenomena characteristic of Raynaud's disease. Buerger's sign was positive. Oscillometric examination of the four extremities indicated markedly diminished oscillation in the thigh, calf, ankle, foot, arm, and wrist, with marked spasm. Urine was negative, red blood-cells 4,010,000, hæmoglobin 98 per cent., white blood-cells 9,600, polymorphonuclear leucocytes 76 per cent., Kline test negative, serum calcium 9.5, serum phosphorus 4.3, phosphatase 1.7 (Bodansky units). Calcium tolerance test indicated a disturbance of calcium metabolism.

From a survey of the facts in this case, it was felt that this patient was suffering from Raynaud's disease, probably accompanied by spasm of the coronary arteries. She was placed upon a high calcium and high vitamin diet without any improvement in her symptoms. Accordingly, she was considered a favorable case for parathyroidectomy, and was admitted to the New York Hospital on June 28, 1934.

After preliminary treatment with parathormone and calcium gluconate, the operation was performed on July 21, 1934. The right superior parathyroid gland was found opposite the thyroid cartilage. It appeared twice the normal size. The right inferior parathyroid gland was found just below the inferior thyroid vein near its emergence from the gland. It was about the same size as the superior one. Both left parathyroid glands were isolated in the same situation. They, too, were enlarged. The right superior and the left inferior parathyroid glands were removed *in toto*. The right inferior was subtotally resected.

Examination of the excised parathyroids revealed well-defined hyperplasia. (Fig. 5.) Post-operatively, parathormone was administered for forty-eight hours, and the patient was placed upon a high calcium and high vitamin diet which has continued to date.

Her convalescence was uneventful except for an attack of severe dizziness which lasted for twenty-four hours on the fourth post-operative day. The wound healed by primary union. Since operation, the patient has been very well. There has been the slightest blueness of the finger tips on two occasions only, and this after severe emotional strain. The patient has put on considerable weight, and feels that since the operation, she has been immeasurably improved.

MECKEL'S DIVERTICULUM*

By Charles E. Farr, M.D., and Madeline Penke, M.D.
of New York, N. Y.

Meckel's diverticulum is the most frequent congenital anomaly of the intestinal tract, being found in approximately 2 per cent. of individuals at autopsy; it is apparently noted more often in males than females, in the ratio of about 3:1. The structure is a remnant of the vitello-intestinal or omphalomesenteric duct, which forms the connection between the primitive alimentary canal and the yolk sac in early embryonic life. At that time it consists of an internal layer of endodermal cells and an external layer of mesoderm. During the fourth week of embryonic life, the duct is found as an elongated, narrow tube and is situated in the umbilical cord; very shortly after this (beginning of fifth week) the duct usually separates from the intestine (mid-gut) and begins to atrophy. Remnants of it may be found in the umbilical cord up to the third month (Cunningham[1]).

Various anomalies may occur if the omphalomesenteric duct remains patent entirely or in part. If the portion nearest the small intestine develops further, while the rest atrophies, the type of diverticulum under discussion is formed, which Meckel described in 1813, although earlier observers had noted it also.

The diverticulum is found in man as a blind pouch, protruding from the small intestine, opposite the mesenteric attachment, within one metre above the ileocæcal valve in adults, and 0.3 to 0.5 metres in the new-born. It may vary from three to thirty centimetres in length, and from 1.25 to 5.0 centimetres in diameter (Kaufmann[2]). Its wall is analogous to that of the small intestine, with some variation in the type of mucosa. Usually the latter resembles that of the ileum, but small amounts of pancreatic tissue and structures resembling carcinoids may be found (Schaetz[3]), as well as gastric mucosa.

CASE REPORTS

Case I.—Female, born of healthy parents and with a negative family and personal history other than pertussis and chickenpox. At one and one-half years of age had an attack of dysentery followed immediately by the passage of considerable blood by rectum. This continued in smaller amounts for some time. Another similar attack occurred a year later but of less duration and severity. There was no pain and no symptoms barring those due to a moderate anæmia. A careful proctoscopical study was done at this time with negative findings and later a gastro-intestinal study with X-rays was negative.

At the age of nine, after strenuous exercise, she again passed large quantities of clotted blood. This was well mixed with fæces; was not the tarry blood of a duodenal hæmorrhage, nor the bright blood from rectal bleeding. Shortly afterwards she developed a severe attack of appendicitis and was operated upon by Dr. F. S. Mathews. She

* Read before the New York Surgical Society, October 24, 1934.

was too ill at the time to permit of exploration. In August, 1925, there occurred a severe hæmorrhage into the bowel, followed by lesser amounts over a period of several days. Again there were no symptoms except those of bleeding.

After the bleeding in 1925 the hæmoglobin dropped to 62 per cent.; the red blood-cells to 3,500,000; the blood-clotting time was four minutes. At this time she entered the New York Hospital and was proctoscoped by Doctor Yeomans, with negative result.

In 1930, she re-entered the New York Hospital in November, following an exceedingly severe hæmorrhage. This came on very suddenly and caused an immediate collapse, with the passage of an enormous amount of clotted and fresh blood, mixed with fæcal matter. At this time the red blood-cells dropped to 3,100,000 and again to 2,900,000. The hæmoglobin dropped to 65, 62, 60, and 58 per cent. The blood-pressure dropped from 110/60 to 96/56. The white cells were 11,000, 8,000 and 8,400. The polymorphonuclears were 84 per cent., 72 per cent. and 60 per cent. There was no fever. The pulse ranged from 108 to 84. A flat plate of the abdomen was negative.

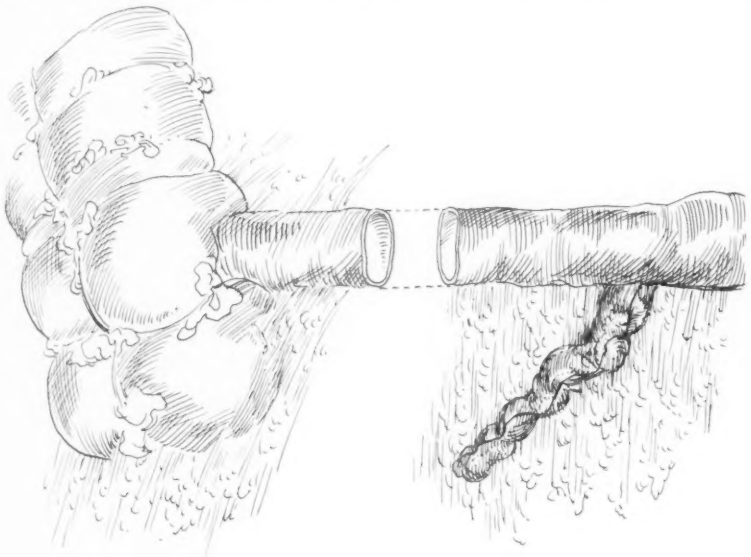


FIG. 1.—(Case I.) Meckel's diverticulum.

During all these years she had been repeatedly seen and studied by various men. Finally, Dr. Joseph Roper made the diagnosis, by exclusion, of a bleeding Meckel's diverticulum. She was re-admitted to the New York Hospital in March, 1931. She had been perfectly well in the interval and with no more bleeding. The physical examination was entirely negative. The red blood-cells were 4,270,000. Hæmoglobin, 70 per cent. The white cells were 17,400 and polymorphonuclears 74 per cent.

Operation.—March 10, 1931. A right rectus incision was used including a part of the old appendix scar. A few omental adhesions were found. The site of the appendix was normal in every way with no adhesions. About two feet above the ileocæcal valve was a Meckel's diverticulum. It lay close to the mesenteric border and faced toward the right. It was approximately 2½ by ½ inches, irregular, nodular, scarred and adherent at its tip by scar tissue to the mesentery of the ileum (Fig. 1). The diverticulum had a mesentery of its own of thin tissue practically without blood-vessels and in the middle of it was a considerable natural opening. It resembled very much an old, inflamed, adherent appendix. The mesentery was tied off and cut and the tip freed. It was then found that the base of the diverticulum was about one-quarter inch from the actual mesentery. The bowel was dilated and hypertrophied

above the lesion to about twice the diameter of that below. There was a marked change in the calibre of the ileum at the point of entrance of the diverticulum. It was excised with some of the wall of the ileum. The opening was closed with three layers of fine chromic catgut continuous without appreciable impingement on the lumen of the bowel. Two or three vessels of considerable size required separate ligation. The right ovary was found to contain a cyst four inches in diameter and this was excised. There was a very marked Harris' band from the gall-bladder to the duodenum and the transverse colon but it was not interfered with. There were also a few adhesions about the right kidney but these were not touched. Closure in layers without drainage.

Pathological Report.—(1)—Diverticulum of gut (Meckel's). (2)—Corpus luteum cyst of ovary. Specimen consists of a diverticulum removed from the small intestine 4.3 centimetres long by 1.3 centimetre in diameter at the distal end and 2.4 centimetres at the base. The surface is fairly smooth and shows a scar near the base about two centimetres long. Distal to it there is a firm nodule. The specimen sectioned longitudinally showed thickened, pale ridges of mucosa extending from one side to the other (Fig. 2). There is also an irregular piece of tissue, said to be an ovarian cyst, measuring seven centimetres by 2.0 centimetres by 1.5 centimetre in size. A part of it shows pale, glistening, ovarian cortex and the rest is brownish in color and shows in one part bright, yellowish tissue.

FIG. 2.—(Case I.) Left, external appearance; right, view of interior, longitudinal section.

Frozen section of a portion of the diverticulum shows a thick mucosa containing many small gland acini. There is loose submucosal tissue and outer and inner layer of musculature. More detail will be given on paraffin sections. Sections of the ovarian specimen show cortical tissue and also lutean cell-lined space containing blood. Paraffin sections show the diverticulum to be lined throughout with a mucosa more or less typically gastric in type. The crypts, lined by clear, columnar cells, have several tubules emptying into them. These are cut mostly in cross section. The tubular lining cells are of the "chief" type with quite frequent "parietal" eosinophilic cells (Fig. 3). The rest of the wall consists of the usual layers. The muscularis mucosa is not very distinct. The main muscle coat has inner circular and outer longitudinally arranged layers. The base of the diverticulum shows a transition of the gastric type of mucosa to that of the small intestine. No evidence of present nor past hæmorrhage is seen, nor active ulceration.

In the three and one-half years since this operation there have been no symptoms whatever. The girl has been in perfect health.

CASE II.—A boy, six years and two months of age, was seen by me February 25, 1934, for severe bleeding from the rectum. There was a history that at five months of age the child had bloody stools which lasted two and one-half days. The bleeding

was not severe and stopped spontaneously. About three months later the bleeding reappeared for a short time. The history was otherwise negative. He never had any feeding nor digestive difficulty. Pertussis at three years of age. He had been admitted to the Fifth Avenue Hospital on September 6, 1928, for intestinal hæmorrhage and secondary anæmia, with the history of passing blood by rectum at intervals for four days. A proctoscopic examination showed no polyps and no ulceration. Hæmoglobin was 45 per cent. and the red blood-cells were 2,500,000. He was transfused with his father's blood, receiving eighty cubic centimetres of whole blood, and returned home in improved condition.

The present attack began February 25, 1934. He was seen at once by Dr. F. H. Bartlett who made the diagnosis of bleeding from Meckel's diverticulum. This attack began with complaint of abdominal pain, which was not severe, and with vomiting. An enema was administered with some relief. On February 26

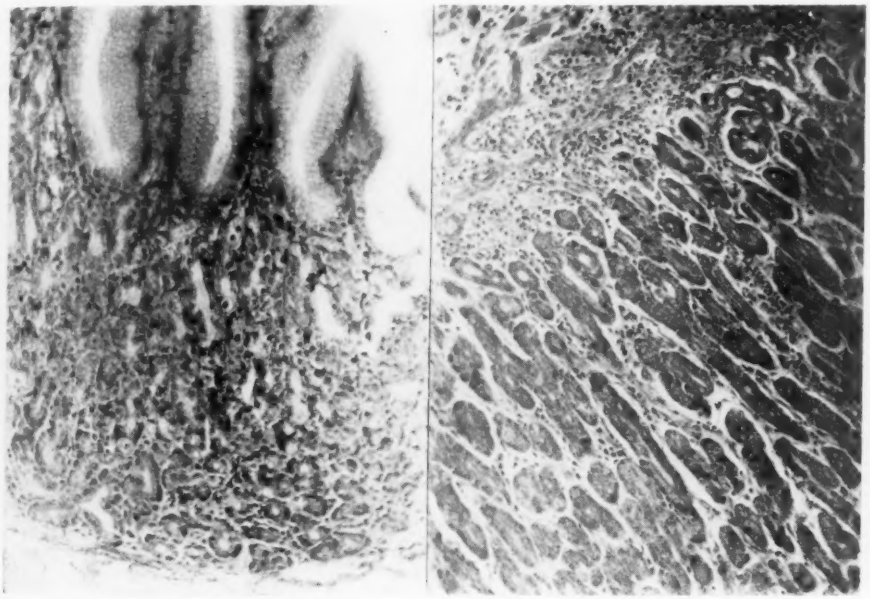


FIG. 3.—(Case I.) Low- and high- power magnification, showing gastric mucosa.

a rather severe hæmorrhage occurred from the rectum and the bleeding continued rather profusely all that evening. This was accompanied by vomiting and the child became very pale and restless. There was no blood in the vomitus. Morphine sulphate 0.004 was administered hypodermically and a colon irrigation given. The return was bright red blood, small clots and much flatus. The irrigation was repeated on March 1, with return of dark red blood and a few clots. There was a recurrence of vomiting at midnight and at 6 A.M. The pulse ranged throughout this extra-hospital period from 120 to 140 per minute; respirations twenty-four. On the morning of March first there was some slight abdominal rigidity and vomiting of a projectile type but the fluid was clear.

The family history was negative except for an old, healed tuberculous lesion in the father. The child was removed to the Fifth Avenue Hospital because of the continued hæmorrhages and vomiting. Physical examination showed a child markedly pale, acutely ill, well nourished, slightly dyspnœic, not cyanotic, resting quietly in bed but slightly confused. Physical examination was essentially negative except for the marked pallor. There was a congenital dimple just above the sternal notch, presumably the

remnant of a lateral pharyngeal sinus. The abdominal examination was negative except for slight tenderness below the umbilicus on both sides. Temperature was 101; pulse 132; respirations 24. Hæmoglobin 27 per cent. Red blood-cells 1,050,000. White blood-cells 9,100. Polymorphonuclears 76. Lymphocytes 21. Monocytes 3. Platelets 400,000. Coagulation time, three and three-quarter minutes.

Flat films of the abdomen were made by Doctors Cole and Pound, and reported as follows: "There is a collection of gas throughout the intestinal tract and a number of dilated coils. In the right upper quadrant is an area free from gas although gas is present in the bowel above and below this spot. This gives the impression of some

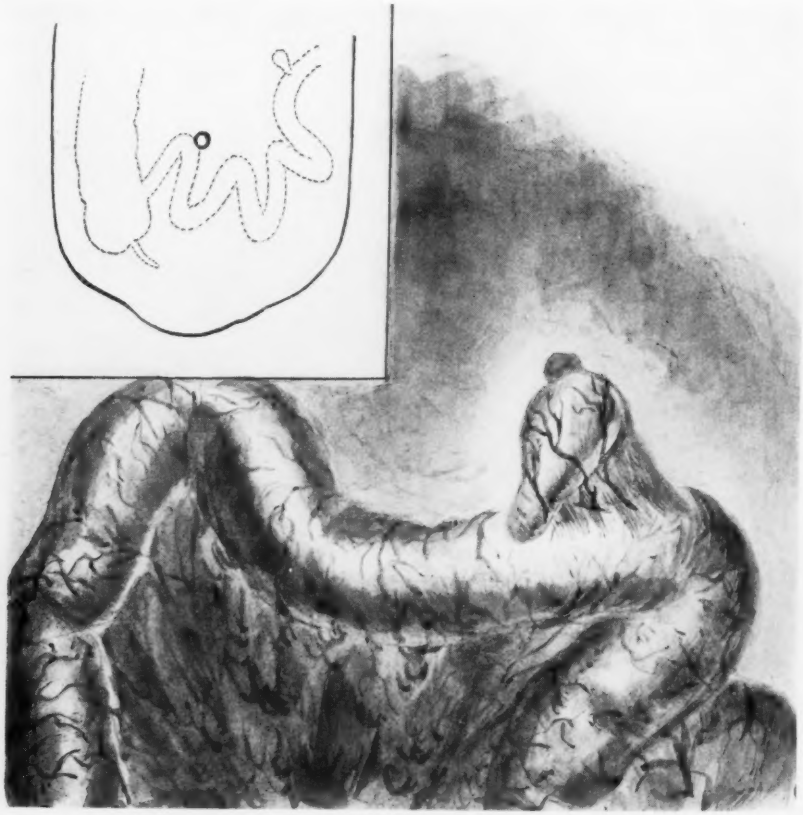


FIG. 4.—(Case II.) Gross appearance of Meckel's diverticulum. Insert shows the position relative to the ileocæcal valve.

kind of mass. A barium enema passed to the hepatic flexure without obstruction or delay. There is a collection of gas in the dilated small bowel, filling the area below the hepatic flexure. The weight of the evidence is definitely in favor of some type of intussusception."

Urinalysis was negative except for a very faint trace of albumin and an occasional white blood-cell. A transfusion of whole blood was given by the Soresi method on admission to the hospital, 300 cubic centimetres with the father as donor. And again at 7 P.M. 500 cubic centimetres were given immediately preceding the operation.

Operation.—A high, right rectus incision was made and the muscle split. No free fluid was found. The ileum was much distended and cæcum could not be seen nor felt. The large bowel was then inflated through a rectal tube which had been inserted

previously. There was much blood in the cæcum and ascending colon. No intussusception. The appendix was long, full of blood but normal. There were flecks of blood in the ileum, which was followed up approximately three feet or a little more. Here a Meckel's diverticulum was found about 1½ inches in length, ¾ inch in width at the widest place, narrowing as it approached the ileum to ½ inch. It was on the antimesenteric border and had a mesentery of its own which contained a vessel of considerable size (Fig. 4). An intestinal clamp was placed around this loop and the diverticulum cut away. There were two good-sized, spurting vessels in the margin. These were controlled by silk ligatures. The intestinal wound was closed with interrupted fine silk in two layers, with slight diminution of the calibre of the intestine. Closure with considerable difficulty because of distention. Continuous double chromic for the peritoneum, including an occasional bite of muscle. Interrupted chromic for the fascia and clips for the skin.

Pathological Report.—Specimen consists of a Meckel's diverticulum measuring four

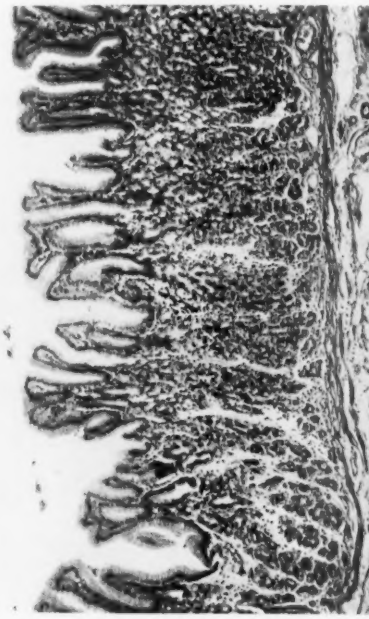


FIG. 5.—(Case II.) Photomicrograph, showing gastric mucosa.

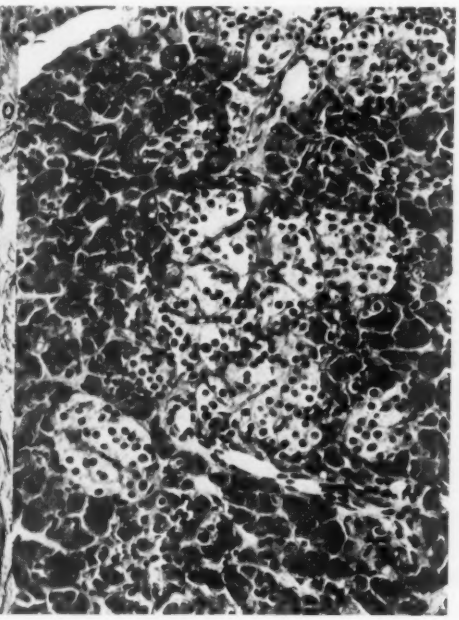


FIG. 6.—(Case II.) High-power view of pancreatic tissue, showing well-developed islands of Langerhans.

centimetres in length, 1.2 centimetres in diameter at the base and two centimetres in diameter at the fundus. It is bulbous in shape; surface is covered by smooth serosa except at one spot. It contains clear watery fluid. The wall is four millimetres thick at the base and two millimetres in thickness at the fundus. The specimen is lined by mucous membrane. At the base the mucous membrane is thick, rugate and thrown up into various sized folds, which protrude into the lumen. Near the extreme edge of the base, where the clamp marks are, the mucosa is flattened and seems to be of a different nature. In the fundus the mucosa has much less thickening. The rugæ are small. On the fundus there is an ovoid swelling 5 by 6 by 1 millimetres in diameter which appears to be a lymph-node. No evidence of hæmorrhage is found.

Microscopical Examination.—One section shows the typical appearance of wall of ileum. The mucosa and muscle layers seem to be a little œdematous. In another section the mucosa is typical of that of stomach and in addition to the chief cells there are some parietal cells (Fig. 5). There is no evidence of inflammation in this

section. Section taken through the protruding nodule at the fundus shows pancreatic tissue with some islands of Langerhans (Figs. 6 and 7). The presence of an ulcer of the intestine opposite the orifice of the diverticulum is a possibility.

The child made an uninterrupted recovery and had a very mild reaction to the operation. The highest post-operative temperature was 101.8, pulse 128, and respirations 28. He returned to normal on the third day. The child was discharged from the hospital on the thirteenth day with a hæmoglobin of 65 per cent. and in excellent general condition. There was much old blood from the bowel for several days post-operative but no fresh bleeding. At present, August 1, 1934, he is in very robust health and has had no symptoms whatever.

CASE III.—A boy, four years and three months of age, was seen by me in consultation May 15, 1934. The chief complaint was of abdominal pain, vomiting, obstipation and the passage of blood by rectum. Doctor Berlinrood, who referred the case to me, had been treating him for seven months for an advanced nephrosis.

The child had developed a severe cold and a week later began to have swelling of

FIG. 7.—(Case II.) Photomicrograph, showing pancreatic tissue and duct.

the eyelids, followed by œdema of the penis and the scrotum with ascites. There was very little œdema of the legs. He was in the Flushing Hospital six weeks. The swelling disappeared entirely but he then developed a rash, high fever and swollen glands. A tonsillectomy had been planned but was abandoned temporarily. A diagnosis of nephrosis had been made.

After a month's rest at home the child appeared entirely well and remained so for a month but in April, 1934, he again began to show œdema of the eyelids, penis, scrotum and swelling of the abdomen. He had been in bed a month. On May 12, 1934, he had severe pain in the hypogastrium requiring morphine. This was followed by fever and repeated vomiting of everything ingested. On May 14 a swelling was noted in the right upper quadrant and a few hours later was noted to be in the right lower quadrant. Ever since that time there has been bright blood in the returns from enemata.

The diagnosis of Meckel's diverticulum with intussusception was entertained by Doctor Berlinrood and his associate. The child had albuminuria since the onset seven months ago and hæmaturia during the past two weeks.

Physical examination showed a pale, very anæmic, acutely ill child with marked

puffiness of the eyelids and distended abdomen. The temperature on admission to the New York Hospital was 37.4; pulse 80; and respirations 22. The tonsils were large, infected, and the crypts full of exudate. The pharynx was red, tongue clean. There were many shotty lymph-nodes in the upper chains. The heart was enlarged to the left and its action was rapid but otherwise negative. The abdomen was distended; there was shifting dullness in the flanks; the superficial veins of the upper abdominal wall were moderately distended; the small bowel pattern could be seen on the surface but there was no visible peristalsis nor audible gurgling on auscultation. A hard, irregular, somewhat tender mass, the size of a closed fist, could be felt in the hypogastrium, somewhat to the right of the mid-line. It could be moved slightly and was not attached to the overlying skin. Extremities and reflexes were normal. Rectal examination was negative. There was generalized shotty lymphadenopathy.

Under the fluoroscope the barium enema was seen to pass through the ileocæcal valve after some delay. There was no evidence of obstruction in the large bowel. X-ray films, however, showed a typical step-ladder arrangement suggesting small bowel obstruction.

The laboratory findings on admission: Urine specific gravity of 1030, acid, albumin four plus, negative for sugar, white blood-cells one to six and red blood-cells were one to three per field. On May 17 post-operative report was: Albumin four plus, sugar negative, many granular and hyaline casts, few red cells, many white blood-cells with occasional clumps. Hæmoglobin was 75 per cent., leucocytes 18,400, polymorphonuclears 80 per cent., lymphocytes 20 per cent. On the sixteenth the fluid intake was 530 cubic centimetres, the output thirty cubic centimetres. On the seventeenth the fluid intake was 256 cubic centimetres, the output forty-five cubic centimetres.

Operation.—May 16, under local anæsthesia by infiltration. The right rectus was split. A large amount of clear serum was evacuated. A mass about the size of a fist could be felt near the mid-line and attached to the posterior abdominal wall. It consisted of several coils of ileum which were firmly intussuscepted and could not be reduced. If pressure was exerted the serosa split. The mass was then resected by clamps and sutures and a lateral anastomosis performed with chromic catgut and Pagenstecher. There was an ample stoma about four centimetres in length. No exploration was carried out. The wound was closed without drainage. Time one and one-half hours.

A transfusion of 200 cubic centimetres whole blood was given on May 17. The child appeared to do fairly well after the operation, sat up in bed and demanded tomato juice, but apparently the kidneys refused to function and the child died May 18 at 3 A. M.

Pathological Report.—The specimen consists of thirty-seven centimetres of gangrenous small intestine, covered by a thick, fibrinous exudate. At one end there is a blackened, necrotic Meckel's diverticulum. It appears that the base of the diverticulum formed the leading point and dragged the remainder of the diverticulum, together with the ileum, through the ileocæcal valve thus telescoping the gut. This has been reduced and it is therefore impossible to reconstruct the specimen. The sections show such complete gangrene and necrosis that only a portion of the least important structures, such as connective tissue and mesentery fat, are recognizable. Nothing can be deduced as to the general topography of the specimen. One section shows greatly inflamed ileum and probably represents the least affected portion of the gut removed at the operation.

CASE IV.—A boy, five months of age, entered St. Mary's Hospital for Children on June 11, 1931, and was discharged June 23, 1931. The chief complaint was of abdominal cramps, vomiting and blood in the stools. The past history was negative except for an otitis media and a small umbilical hernia. The infant was breast fed, supplemented by milk. An interesting point in the family history was that an older brother had an exactly similar condition at seven months of age.

The present illness began four hours before admission. The noon feeding was taken normally. At 1 P.M. the infant awoke crying and very pale. He vomited and cried as if in pain, and kept his thighs flexed on the abdomen. An enema was given with a

return of water and some mucus. Castor oil was administered. Soon after the enema was ejected the infant had a spontaneous movement, containing a considerable amount of blood and some mucus. He was taken to Dr. Homer Cudmore who made the diagnosis of intussusception and stated he could feel a mass. He referred the infant at once to the hospital. Upon reaching there the mother said that the baby's color and condition had improved remarkably. He had stopped crying, had vomited only twice, but had four or five frankly bloody stools with mucus. The physical examination was negative except for a discharging ear and a small umbilical hernia. The rectal examination was negative although the finger brought away bright blood and some mucus. The white blood-count, June 11, was 25,000; polymorphonuclears 42 per cent. June 12, 24,000 with 34 per cent. polymorphonuclears; June 17, 12,000 with 51 per cent. polymorphonuclears.

Under the fluoroscope, with an injection of air into the colon, and again later, with the use of a barium enema and a film, no intussusception was found. His condition improved and there was a normal stool. Three days later, June 14, the infant became drowsy, refused his feeding, vomited, and passed two bloody, mucoid stools. He was operated upon at once and an intussusception was found.

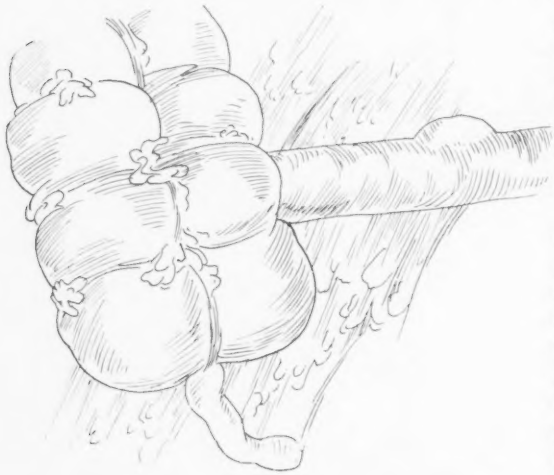


Fig. 8.—(Case IV.) Reduced intussusception, showing the presumed Meckel's diverticulum which caused the telescoping of the ileum.

By rectal injection of air under pressure the entire intussusception was easily reduced, as the air passing through the ileocæcal valve pushed the portion of ileum which was intussuscepted before it, and everything seemed to be returned to normal, but on careful inspection there was found a dimple in the ileum about fifteen centimetres from the ileocæcal valve on the antimesenteric border. On palpation this area proved to be moderately infiltrated. With slight manipulation the dimple became a protruding mass about 3 by 2 centimetres and about one centimetre high (Fig. 8). There appeared to be no tendency for this to intussuscept again and it was not deemed wise to remove it. There is no definite proof that this was a Meckel's diverticulum, but it had all the characteristics as to shape and location, and appeared to be the cause of the intussusception. The child has remained well ever since.

Cases I and II were positively diagnosed before operation as bleeding Meckel's diverticula and so proven by operation and the follow-up.

Case III was suspected of being a bleeding Meckel's diverticulum with intussusception. The latter was proven at operation but the specimen was so necrotic that it was impossible to determine whether this was a true case of a bleeding diverticulum or only the ordinary hæmorrhage found in intussusception.

Case IV presented the usual picture of intussusception in an infant. The Meckel's diverticulum was undoubtedly the true cause of the intussusception but the hæmorrhage was, in all probability, due to the intussusception as such

and not to the diverticulum. As further proof of this the child has remained perfectly well since operation and has had no further bleeding, although the diverticulum was not removed.

The occurrence of gastric mucosa and pancreatic tissue in the cases reported was regarded as rather unusual and led to a review of the surgical and autopsy files of the Pathological laboratory of the New York Hospital, in a search for similar cases, with the following results.

CASE REPORTS

From the Surgical and Autopsy Files of the New York Hospital

Surgical.—CASE I.—Female. Nineteen years of age. Reported severe intestinal hæmorrhage. Physical examination was negative. Diverticulectomy performed. Patient recovered. Gross specimen.—Meckel's diverticulum two feet from ileocæcal valve. Apparently scarred. Microscopical examination.—Gastric mucosa throughout Meckel's diverticulum.

CASE II.—Male. Twenty-five years of age. Right inguinal hernia. Herniorrhaphy performed. Patient recovered. Gross specimen.—Small diverticulum from hernial sac. Microscopical examination.—Intestinal mucosa moderately infiltrated with lymphocytes.

CASE III.—Female. Thirty years of age. Dragging hypogastric pain for four or five years. Appendectomy, oöphorectomy and resection of diverticulum. Patient developed intestinal obstruction but recovered. Gross specimen.—Diverticulum fifteen centimetres from ileocæcal valve. Microscopical examination.—Intestinal mucosa.

CASE IV.—Female. Twenty-five years of age. Dull pain in right iliac region for several months. Severe for two weeks. Appendectomy, diverticulectomy. Microscopical examination.—Intestinal mucosa.

CASE V.—Female. Forty-three years of age. Steady pain in left abdomen four days. Mass in left lower abdomen. White blood-count 13,000; polymorphonuclears 75 per cent. Laparotomy performed with recovery. Gross specimen.—Left hæmatosalpinx, diverticulum 3 by 1 by 2 centimetres. Microscopical examination.—Normal layers of small intestines.

CASE VI.—Male. Twenty-five years of age. Severe cramps. Vomiting of blood and green fluid for two days. Marked epigastric tenderness. Intestinal obstruction. White blood-count 10,200; polymorphonuclears 65 per cent. Resection of ileum for obstruction at site of Meckel's diverticulum. Died day of operation. Shock, paralytic ileus. Microscopical examination.—Intestinal and gastric mucosa with much hæmorrhage between mucosa and muscularis.

CASE VII.—Male. Twenty-two years of age. Attacks acute. Right lower quadrant pain one week. Nausea and vomiting. Appendectomy and diverticulectomy. Patient recovered. Microscopical examination.—Intestinal mucosa.

CASE VIII.—Male. Two and three-quarters years of age. Pain in the right abdomen for ten hours, sudden and severe with vomiting. Slight fullness in right lower quadrant to the right of the umbilicus. Intussusception. Had one stool with fresh blood. White blood-count 7,800; polymorphonuclears 89 per cent. Diverticulectomy. Terminal ileum, intussusception on itself into cæcum and ascending colon. Diverticulum at beginning of mass. Patient recovered. Gross specimen.—Meckel's diverticulum 1.2 by 1.0 inches. Microscopical examination.—Intestinal and gastric mucosa and one small island of pancreatic tissue.

CASE IX.—Male. Thirteen years of age. Aching pain about the umbilicus for one month. Tenderness. White blood-count 9,000; polymorphonuclears 79 per cent. Diverticulectomy. Patient recovered. Gross specimen.—Meckel's diverticulum 1.5 by 1.75 inches. Fourteen inches from the ileocæcal valve with some adhesions. Microscopical examination.—Intestinal mucosa.

return of water and some mucus. Castor oil was administered. Soon after the enema was ejected the infant had a spontaneous movement, containing a considerable amount of blood and some mucus. He was taken to Dr. Homer Cudmore who made the diagnosis of intussusception and stated he could feel a mass. He referred the infant at once to the hospital. Upon reaching there the mother said that the baby's color and condition had improved remarkably. He had stopped crying, had vomited only twice, but had four or five frankly bloody stools with mucus. The physical examination was negative except for a discharging ear and a small umbilical hernia. The rectal examination was negative although the finger brought away bright blood and some mucus. The white blood-count, June 11, was 25,000; polymorphonuclears 42 per cent. June 12, 24,000 with 34 per cent. polymorphonuclears; June 17, 12,000 with 51 per cent. polymorphonuclears.

Under the fluoroscope, with an injection of air into the colon, and again later, with the use of a barium enema and a film, no intussusception was found. His condition improved and there was a normal stool. Three days later, June 14, the infant became drowsy, refused his feeding, vomited, and passed two bloody, mucoid stools. He was operated upon at once and an intussusception was found.

FIG. 8.—(Case IV.) Reduced intussusception, showing the presumed Meckel's diverticulum which caused the telescoping of the ileum.

By rectal injection of air under pressure the entire intussusception was easily reduced, as the air passing through the ileocæcal valve pushed the portion of ileum which was intussuscepted before it, and everything seemed to be returned to normal, but on careful inspection there was found a dimple in the ileum about fifteen centimetres from the ileocæcal valve on the antimesenteric border. On palpation this area proved to be moderately infiltrated. With slight manipulation the dimple became a protruding mass about 3 by 2 centimetres and about one centimetre high (Fig. 8). There appeared to be no tendency for this to intussuscept again and it was not deemed wise to remove it. There is no definite proof that this was a Meckel's diverticulum, but it had all the characteristics as to shape and location, and appeared to be the cause of the intussusception. The child has remained well ever since.

Cases I and II were positively diagnosed before operation as bleeding Meckel's diverticula and so proven by operation and the follow-up.

Case III was suspected of being a bleeding Meckel's diverticulum with intussusception. The latter was proven at operation but the specimen was so necrotic that it was impossible to determine whether this was a true case of a bleeding diverticulum or only the ordinary hæmorrhage found in intussusception.

Case IV presented the usual picture of intussusception in an infant. The Meckel's diverticulum was undoubtedly the true cause of the intussusception but the hæmorrhage was, in all probability, due to the intussusception as such

and not to the diverticulum. As further proof of this the child has remained perfectly well since operation and has had no further bleeding, although the diverticulum was not removed.

The occurrence of gastric mucosa and pancreatic tissue in the cases reported was regarded as rather unusual and led to a review of the surgical and autopsy files of the Pathological laboratory of the New York Hospital, in a search for similar cases, with the following results.

CASE REPORTS

From the Surgical and Autopsy Files of the New York Hospital

Surgical.—Case I.—Female. Nineteen years of age. Reported severe intestinal hæmorrhage. Physical examination was negative. Diverticulectomy performed. Patient recovered. Gross specimen.—Meckel's diverticulum two feet from ileocæcal valve. Apparently scarred. Microscopical examination.—Gastric mucosa throughout Meckel's diverticulum.

Case II.—Male. Twenty-five years of age. Right inguinal hernia. Herniorrhaphy performed. Patient recovered. Gross specimen.—Small diverticulum from hernial sac. Microscopical examination.—Intestinal mucosa moderately infiltrated with lymphocytes.

Case III.—Female. Thirty years of age. Dragging hypogastric pain for four or five years. Appendectomy, oöphorectomy and resection of diverticulum. Patient developed intestinal obstruction but recovered. Gross specimen.—Diverticulum fifteen centimetres from ileocæcal valve. Microscopical examination.—Intestinal mucosa.

Case IV.—Female. Twenty-five years of age. Dull pain in right iliac region for several months. Severe for two weeks. Appendectomy, diverticulectomy. Microscopical examination.—Intestinal mucosa.

Case V.—Female. Forty-three years of age. Steady pain in left abdomen four days. Mass in left lower abdomen. White blood-count 13,000; polymorphonuclears 75 per cent. Laparotomy performed with recovery. Gross specimen.—Left hæmatosalpinx, diverticulum 3 by 1 by 2 centimetres. Microscopical examination.—Normal layers of small intestines.

Case VI.—Male. Twenty-five years of age. Severe cramps. Vomiting of blood and green fluid for two days. Marked epigastric tenderness. Intestinal obstruction. White blood-count 10,200; polymorphonuclears 65 per cent. Resection of ileum for obstruction at site of Meckel's diverticulum. Died day of operation. Shock, paralytic ileus. Microscopical examination.—Intestinal and gastric mucosa with much hæmorrhage between mucosa and muscularis.

Case VII.—Male. Twenty-two years of age. Attacks acute. Right lower quadrant pain one week. Nausea and vomiting. Appendectomy and diverticulectomy. Patient recovered. Microscopical examination.—Intestinal mucosa.

Case VIII.—Male. Two and three-quarters years of age. Pain in the right abdomen for ten hours, sudden and severe with vomiting. Slight fullness in right lower quadrant to the right of the umbilicus. Intussusception. Had one stool with fresh blood. White blood-count 7,800; polymorphonuclears 89 per cent. Diverticulectomy. Terminal ileum, intussusception on itself into cæcum and ascending colon. Diverticulum at beginning of mass. Patient recovered. Gross specimen.—Meckel's diverticulum 1.2 by 1.0 inches. Microscopical examination.—Intestinal and gastric mucosa and one small island of pancreatic tissue.

Case IX.—Male. Thirteen years of age. Aching pain about the umbilicus for one month. Tenderness. White blood-count 9,000; polymorphonuclears 79 per cent. Diverticulectomy. Patient recovered. Gross specimen.—Meckel's diverticulum 1.5 by 1.75 inches. Fourteen inches from the ileocæcal valve with some adhesions. Microscopical examination.—Intestinal mucosa.

CASE X.—Male. Sixteen years of age. Pain in umbilical region, radiating to right lower quadrant, four days. Less severe attacks since childhood. Diverticulitis. White blood-count 8,700; polymorphonuclears 72 per cent. Diverticulectomy with removal of band extending from mesentery, near ileocæcal valve, nearly to umbilicus. Recovered after stormy post-operative course. Gross specimen.—Meckel's diverticulum 12 by 1.5 inches. Twenty-eight inches from ileocæcal valve. Microscopical examination.—Intestinal and gastric mucosa.

CASE XI.—Female. Fifteen years of age. Weakness, dull abdominal pain for five weeks. White blood-count 11,600; polymorphonuclears 87 per cent. Removal of gangrenous Meckel's diverticulum found in an inflammatory mass involving the ileum. Patient recovered. Gross specimen.—Gangrenous Meckel's diverticulum. Microscopical examination.—Intestinal and gastric mucosa. Chronic exudate and proliferative inflammation.

CASE XII.—Male. Fourteen years of age. Tumor at umbilicus since birth. Bleeds occasionally. Fiery red, pedunculated, 2 by 1 centimetres. Removal of tumor, extending down to fascia and ending as thin band. Patient recovered. Gross specimen.—Meckel's diverticulum 2 by 1 centimetres. Microscopical examination.—Gastro-intestinal epithelium with red cell-infiltration.

CASE XIII.—Male. Forty-seven years of age. Three attacks of abdominal pain, right lower quadrant, for two days, severe then subsided. Tenderness at McBurney's point. Acute appendix. White blood-count 6,200; polymorphonuclears 70 per cent. Diverticulectomy with recovery of patient. Gross specimen.—Meckel's diverticulum 3.5 by 1.0 inches, near ileocæcal valve, acutely inflamed. Microscopical examination.—Intestinal mucosa and acute inflammatory changes.

Autopsy.—*Case I.*—Male. Forty-six years of age. Cause of death pyæmia from infected finger. Gross specimen.—Diverticulum three inches long. Three feet from ileocæcal valve.

CASE II.—Male. Thirty-nine years of age. Cause of death lobar pneumonia. Gross specimen.—Diverticulum thirty centimetres from ileocæcal valve.

CASE III.—Male. Seventy years of age. Gross specimen.—Diverticulum 6 by 1 centimetres. Lower part of small intestines.

CASE IV.—Male. Sixty-one years of age. Cause of death chronic nephritis, myocarditis. Gross specimen.—Diverticulum 15 by 30 millimetres.

CASE V.—Male. Four days old. Cause of death bronchopneumonia. Gross specimen.—Diverticulum 1.5 centimetre long. In small intestine. Congenital anomalies; spina bifida, club feet, cleft palate, foramen ovale.

CASE VI.—Male. Thirty-nine years of age. Cause of death acute nephritis. Gross specimen.—Diverticulum three inches long. Four feet from ileocæcal valve.

CASE VII.—Male. Fifty-two years of age. Cause of death chronic myocarditis. Gross specimen.—Diverticulum five centimetres long. In ileum.

CASE VIII.—Male. Sixty years of age. Cause of death carcinoma of seminal vesicles. Gross specimen.—Diverticulum three centimetres long. Three feet from ileocæcal valve.

CASE IX.—Female. Thirty-five years of age. Cause of death acute endocarditis. Gross specimen.—Diverticulum 2.5 centimetres long. One metre from ileocæcal valve.

CASE X.—Female. Sixty-five years of age. Cause of death endocarditis. Gross specimen.—Diverticulum 100 centimetres distal to duodenojejunal flexure.

CASE XI.—Male. Fifty-four years of age. Cause of death septic infarcts of both lungs. Pericarditis. Gross specimen.—Diverticulum 2.5 centimetres, with three vesicular diverticula three millimetres long.

CASE XII.—Male. Twenty-two years of age. Cause of death lobar pneumonia. Gross specimen.—Diverticulum 186 centimetres from ileocæcal valve. Congenital anomalies.—Patent foramen ovale. Hypoplasia of aorta.

CASE XIII.—Male. Forty-one years of age. Cause of death peritonitis and intestinal obstruction. Gross specimen.—Diverticulum 4 by 0.5 centimetres. Eight inches of terminal ileum, black and caught in loop by band of tissue running from ileum to sigmoid. Microscopical examination.—Small lumen near ileum with remnants of intestinal mucosa.

CASE XIV.—Female. Forty-eight years of age. Cause of death carcinoma of cystic duct. Gross specimen.—Diverticulum 4 by 2 centimetres. Microscopical examination.—Intestinal mucosa.

CASE XV.—Male. Twenty-five years of age. Cause of death scarlet fever. Gross specimen.—Diverticulum fifteen centimetres above cæcum. Microscopical examination.—Gastric mucosa near tip, the rest intestinal mucosa.

Various disturbances to which the partially persistent omphalomesenteric duct may give rise, are illustrated, *i.e.*, intestinal obstruction, Case VI; intussusception, Case VIII; remnant of omphalomesenteric duct at umbilicus, Case XII; acute diverticulitis with symptoms similar to those of acute appendicitis, Case XIII; chronic inflammatory changes, Case XI; strangulation of gut, Autopsy 13. The localization of pain in the region of the umbilicus, with recurring attacks, was present in Cases IX and X. In Cases II, III, and IV the diverticulum was apparently innocuous, and an incidental finding, although in Case II it formed part of the contents of an inguinal hernia.

It is interesting to note that no mention was made of bloody stools nor severe intestinal hæmorrhage, except in Case I reported in detail above, and in Case VIII. Gastric mucosa was found in six of the thirteen surgical cases, but evidently only in Case I did it form practically the entire diverticular mucosa.

Autopsy reports in 2,050 autopsies at the New York Hospital (1916–1931), showed that the diverticulum had been an incidental finding thirteen times and had caused a strangulation of the intestines once.

No tumor of the diverticulum, such as have been described by Symmers,[4] Wisely[5] and others, was found in any specimen. A small area of pancreatic tissue was noted in Case VIII.

No other congenital anomalies were noted in any of the patients, except in two, at autopsy.

Griffith,[12] in 1914, noted the presence of blood in the stools as one of the diagnostic features of diverticulitis. In 1915, Callender[13] found a small ulcer in the ileum at the border of a diverticulum containing gastric mucosa, in a child dying following intestinal hæmorrhage. Jackson,[14] in 1915, found intestinal hæmorrhage associated with an ulcer of Meckel's diverticulum and an eroded vessel close by; he considered the condition as due possibly to tuberculosis. In 1919, Goetsch[15] found a diverticulum lined by cherry-red, granular folds of mucosa in its distal quarter. Careful sectioning and staining proved that this area was gastric mucosa of the fundus type.

More recently, Stulz[7] and Woringer, among others, have stressed especially the occurrence of intestinal hæmorrhage and increasing anæmia with symptoms of perforation later, due to an ulcer developing in the diverticulum at the edge of an island of heterotopic gastric mucosa. It is considered that an ulcer may develop in the neighboring intestinal mucosa, due possibly to

the digestive action of the secretion produced by the gastric glands in the mucosa. This is difficult to determine experimentally, but in some of the cases in which gastric mucosa was noted at the umbilicus it was found to secrete an acid juice, Tillmanns (1882) Rosthorn, quoted from Schaetz.[16] Its effect, if any, on adjoining intestinal mucosa is probably in proportion to the amount of gastric tissue present in the diverticulum and to the number of glands it contains. Once an ulcer is formed, however, with subsequent erosion of a blood-vessel, it may give rise to the definite symptoms of intestinal bleeding, at times, without other complaints. The condition has apparently been found to give rise to clinical symptoms chiefly in young children and in males rather than females. In children it must be differentiated from intussusception, in which the symptoms are usually more acute, but which necessitates surgical interference also. Hæmorrhagic disease of the newborn manifests itself within the first few days of life, much earlier than the bleeding from Meckel's diverticulum appears to have been found, and hæmorrhage usually occurs from all the mucous membranes. In males hæmophilia must be considered, and could probably be eliminated if there is no history of prolonged bleeding from cuts, together with a negative family history, and normal clotting time. Purpura hæmorrhagica could probably be differentiated by the absence of petechiæ, normal clotting and bleeding time, and normal platelet count, found in bleeding from Meckel's diverticulum; the occurrence of abdominal pain, with questionable evidence of purpura, and slight intestinal hæmorrhage would make it difficult to distinguish between Henoch's purpura, and bleeding from Meckel's diverticulum, without further observation. Those cases would seem to be most difficult to diagnose, in which there is slight abdominal pain, little blood noted in the stools and early perforation with evidence of peritonitis. In adults, in addition to the conditions noted above, bleeding from a gastric or duodenal ulcer must be considered. This may usually be differentiated by the history of symptoms accompanying these ulcers, such as blood in vomitus, tarry stools, and by previous röntgenologic findings, or their determination after the bleeding has subsided. Bleeding from a gastro-intestinal tumor is more frequently found in older individuals; it is usually associated with more or less definite symptoms pointing to such a tumor, the existence of which may be confirmed by röntgenologic evidence. The presence of polyps, ulcers, and hæmangiomas of the bowel can usually be proven by röntgenologic or proctologic examination.

Among the more recent contributions on Meckel's diverticulum are those of Miller and Wallace[8] who give a table of 201 cases, compiled from the recent literature. Of these, ninety-three showed ulcers with hæmorrhage, or perforation, or both. Sixty-three showed intussusception. Twenty-six gave other intestinal obstruction. Ten showed acute inflammation. Miscellaneous conditions were found in nine.

They report forty cases from the clinic of the Massachusetts General Hospital of which twenty-two were causing acute symptoms. The diagnosis of Meckel's diverticulum was not made in any instance.

An article by Henry N. Harkins[9] gives a very extensive bibliography and excellent tabulation of case histories. It cannot be quoted at length but is well worth studying by anyone interested in the subject of Meckel's diverticulum. It is particularly valuable in the presentation of symptoms.

F. S. Mathews[10] presents the largest personal collection of one surgeon that I have been able to find. Turner[11] found a Meckel's diverticulum in 1.3 per cent. in 25,149 necropsies (quoted by Harkins[9]). Harkins also states that a tumor was found at the tip of a Meckel's diverticulum in twenty-six of 114 cases in his series and that forty-nine tumors all told are on record. Of these, one-third contained pancreatic tissue, and over one-half had produced intussusception. He also states (quoting Michael and Bell) that there have been collected eleven cases of malignant tumor of Meckel's diverticulum, including one adeno-carcinoma.

It is interesting to know that a Meckel's diverticulum may be passed spontaneously by rectum, following intussusception. Thus Eliot and Corscaden in a collection of 300 intussusceptions in adults stated that forty-three had passed the intussusception by rectum and, of these, two had a Meckel's diverticulum attached.

The mortality, according to Harkins,[9] is 22 per cent. for those operated upon within twelve hours of the onset; 42 per cent. for those between twelve and twenty-four hours; 31 per cent. for those between twenty-four and forty-eight hours; 47 per cent. for those between forty-eight and seventy-two hours and 58 per cent. for those over seventy-two hours.

The incidence of gastric mucosa in Meckel's diverticulum is difficult to estimate. It was found by Schaetz[3] in five out of thirty cases coming to autopsy from causes other than affections of the diverticulum. He also found other types of epithelium in the diverticulum; at or near the tip, in three out of thirty cases, and in one case, a few carcinoid cell nests were found near the tip of the diverticulum. There was no mention of intestinal hæmorrhage in any of these cases, and no ulcers were found in the diverticula.

In the present series, six of thirteen surgical cases showed gastric mucosa, and in one of these the mucosa was entirely gastric in type. None of the cases showed any ulceration.

The presence of heterotopic tissue in Meckel's diverticulum is difficult to explain. Albrecht (quoted from Goetsch[15]) states that the endoderm lining the intestinal tube and omphalomesenteric duct, possesses the potentiality of developing into any of the glandular structures in the adult intestine or accessory glands, and under the influence of certain circumstances not fully understood, groups of cells may retain one or the other potentiality. This idea may account for the occasional presence of gastric mucosa in the small intestine, as well as in Meckel's diverticulum, and the occurrence of pancreatic tissue in the stomach wall, small intestine, and Meckel's diverticulum.

Schaetz[3] considers that there may be a transference of endodermal cells lining the primitive intestinal tube in early embryonic life due to rotating

movement of the embryo, and that reimplantation of these cells at narrowed points in the intestinal tract may occur; *i.e.*, at the beginning of œsophagus, in the region of the pylorus and duodenum, and in the obliterating omphalomesenteric duct. Experimental proof of this has been planned by Schaetz.

It may also be that the earliest "anlage" of the stomach and pancreas varies somewhat in location, and is at times nearer the developing omphalomesenteric duct than is usually the case, thus facilitating the inclusion of cells which may later develop into gastric or pancreatic tissue.

The vitello-intestinal duct may have originally had a digestive function and would therefore need a digesting mechanism of its own. Certainly the yolk had to be digested in some fashion. I can find, however, no confirmation of this. Surely the presence of gastric or pancreatic tissue or both in over 50 per cent. of Meckel's diverticula, even on casual examination, would seem to suggest that more than chance is involved.

An interesting problem is also posed as to why certain individuals retain remnants of the duct. This, of course, may be due to an "arrest" in very early intra-uterine life, which would interfere with the normal process of atrophy and disappearance. On the other hand, the presence of any considerable amounts of gastric or pancreatic tissue, with their powerful secretions, would certainly tend to keep the tube open.

The occurrence of gastric mucosa in the gastro-intestinal tract, other than in the stomach, is not as rare as one might suppose. In an excellent discussion of heterotopic gastric mucosa, Schaetz[16] reviewed a number of cases in which small areas of apparently normal gastric mucosa were found in the œsophagus, especially at its upper end, at autopsy (E. Kaufmann[2]). The incidence varies; in ten cases islands of gastric mucosa were found five times (Hewlett). Schridde reported such tissue in 70 per cent. of thirty cases; Glinski reported gastric mucosa in three, 6 per cent. of 1,144 cases (macroscopic examination) and four times in ten cases examined microscopically. Schaetz[16] also reviewed a number of cases in which the omphalomesenteric duct, persisting at the umbilicus, showed gastric, as well as intestinal mucosa. The diverticula of the small intestine, containing gastric mucosa in varying amounts, form another group, and are of particular interest because they may give rise to fairly definite clinical symptoms.

SUMMARY

Four personal cases of persistent Meckel's diverticulum causing clinical symptoms have been presented.

Two had severe but intermittent intestinal bleeding as their outstanding symptom. Both recovered after resection of the diverticulum. The preoperative diagnosis was correctly made in both instances.

In two cases the diverticulum had caused an intussusception. Both bled, one rather severely, the other moderately. In both, the diagnosis of intussusception was correctly made. In one, the presence of a bleeding Meckel's

diverticulum was strongly suspected. This could not be proved at operation. This child died.

The fourth case was the typical intussusception in an infant, in which a Meckel's diverticulum was found as the etiological factor. The bleeding in this case was probably not from an ulcer in the diverticulum.

CONCLUSIONS

Meckel's diverticulum is present in from 1 to 2 per cent. of all humans. A considerable number cause active symptoms and threaten life. The diagnosis of a persistent Meckel's diverticulum may be inferred in those cases which bleed. Excision of the diverticulum is the usual and proper treatment.

REFERENCES

[1] Cunningham: Textbook of Anatomy. 5th ed., revised, p. 61. Wm. Wood and Company, 1923.

[2] Kaufmann, E.: Lehrbuch der Speziellen Pathologischen Anatomie. 7th and 8th ed., vol. 1, p. 569.

[3] Schaetz, G.: Beitrage zur Morphologie des Meckel'schen Divertikel. Beitrage zur Path. Anat. and Ziallg. Path., vol. 74, p. 115, 1925.

[4] Symmers, D.: Association of Malignant Myomata with Meckel's Diverticulum. Annals of Surgery, p. 183, 1909, August.

[5] Wisely, A. N.: Medullary Carcinoma of Meckel's Diverticulum. Jour. Amer. Med. Assn., p. 1949, 1931.

[6] Aschner, P. W., and Karelitz: Peptic Ulcer of Meckel's Diverticulum and Ileum. Annals of Surgery, vol. 91, p. 573, 1930.

[7] Stulz, E., and Woringer, P.: Peptic Ulcer of Meckel's Diverticulum. Annals of Surgery, vol. 83, p. 470, 1926.

[8] Miller, R., and Wallace, R.: Meckel's Diverticulum in Acute Abdominal Emergencies. Annals of Surgery, vol. 98, p. 713, 1933.

[9] Harkins, Henry: Intussusception Due to Invaginated Meckel's Diverticulum. Annals of Surgery, vol. 98, p. 1070, 1933.

[10] Mathews, F.: Meckel's Diverticulum. Arch. of Surg., vol. 10, p. 720, 1925.

[11] Turner: Guy's Hospital Reports, vol. 60, p. 279, 1906.

[12] Griffith, J. P. C.: Diseases Connected with Meckel's Diverticulum with Especial Reference to Diverticulitis. Amer. Jour. Obst., p. 851, 1914.

[13] Callender, G. R.: Gastric Glands in Meckel's Diverticulum. Amer. Jour. Med. Sci., vol. 150, p. 69, 1915.

[14] Jackson, R. H.: Hemorrhagic Ulcer of Meckel's Diverticulum. Annals of Surgery, vol. 80, p. 222, 1924.

[15] Goetsch, E.: The Occurrence of Gastric Mucosa in a Case of Meckel's Diverticulum Producing Intestinal Obstruction. Johns Hopkins Hospital Bulletin, vol. 30, p. 143, 1919.

[16] Schaetz, G.: Die Magenepithel-Heterotopien des menschlichen Vorderdarms. Vichow's Arch., vol. 241, p. 148, 1923.

CARCINOMA OF THE LARGE BOWEL

PART II

THE RECTUM

By Theodore S. Raiford, M.D.
of New York, N. Y.

From the Departments of Surgery and Surgical Pathology of the Johns Hopkins Hospital and University, Baltimore, Md.

Carcinomas of the colon have been taken up in Part I of this paper. This section will deal with malignancies in the rectum. Of the 511 carcinomas of the large bowel occurring in the Johns Hopkins Hospital, 319 were located in the rectum. For the purpose of clinical study this portion of the bowel is arbitrarily divided into four parts. The *upper rectum* or *recto-sigmoid* extends from the distal end of the colon to the ampulla. The *ampulla* comprises the middle portion and extends down to the internal sphincter. The *lower rectum* or *anal canal* forms the remainder of the bowel, a distance of approximately 3 cm. down to the mucocutaneous junction. The *anus* designates the cutaneous portion. The 319 tumors were distributed among these divisions as follows:

Table I

Distribution of 319 Carcinomas of the Rectum

Location	Number of Cases	Percentage
Upper rectum and recto-sigmoid	40	12.5
Middle rectum	160	50.2
Lower rectum	96	20.1
Anus	7	2.2
Location undetermined	16	5.0
Total	319	100.0

There is no definite dividing line between the colon and rectum and the division here used is arbitrarily placed at the sigmoid flexure. Since symptoms of rectal cancer are essentially the same irrespective of the subdivisions, the clinical aspects will be discussed regardless of the location and only such differentiation made as is relevant. The operative treatment will be taken up under certain general types and discussed in view of their applicability to the different portions of the rectum.

Clinical Aspects.—Table II represents the graphic distribution of the tumors in this series among the race, sex and age groups. These coincided closely with the same factors in carcinomas of the colon.

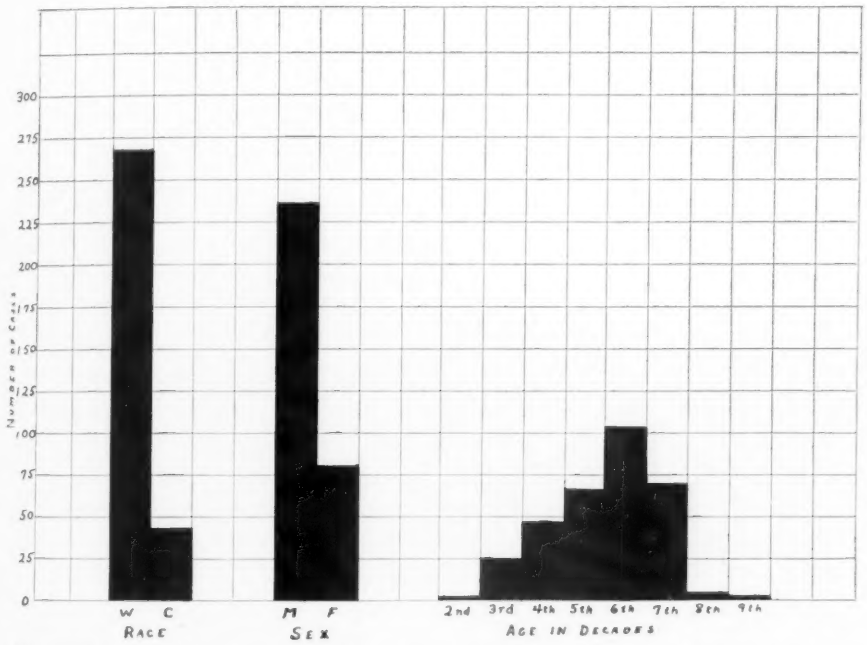
The most constant symptoms of carcinoma of the rectum were lower abdominal discomfort, and difficulty in defecation accompanied by tenesmus. True diarrhœa was not common although some patients had as many as fifteen or twenty stools a day. Neither was constipation the rule, although

bowel movements were sometimes extremely difficult. The "cancer diarrhœa" previously alluded to was occasionally present but the stools were composed primarily of mucus and blood. Rarely was the normal consistency of the fæces altered. The so-called "ribbon stools" have been overemphasized in the author's opinion and perhaps mean very little in the diagnosis of cancer since these are dependent upon other factors, such as the consistency of the fæces and the tonicity of the sphincters.

True pain was an inconstant symptom and usually secondary. Tenderness seldom characterized the mass unless attached to sensitive structures.

TABLE II

Age, Race, Sex Distribution of Carcinomas of the Rectum



Obstruction with its characteristic syndrome was present in many of the high recto-sigmoid growths, but rarely found when the lesion was located in the ampulla.

Complicating symptoms may confuse the diagnosis. Rectal tumors invading surrounding structures such as the prostate, bladder or vagina occasionally simulated malignancy of these structures. Pressure of the tumor on the lumbosacral plexus in a few instances was responsible for a variety of neurological signs and symptoms.

Loss of weight was usually present. The red-cell count was lowered as a rule but not to the extent found in carcinomas of the colon. Weakness and malaise depended upon the duration and extent of the tumor.

Melæna was the most constant sign. Blood from growths located high was usually clotted and dark in color. Fresh hæmorrhage characterized tumors located nearer the anal orifice.

Palpation of the tumor by digital examination was possible when located within 10 to 12 cm. of the external sphincter. Higher growths were occasionally made out with bimanual examination or by having the patient stand in the upright position.

Diagnosis was made comparatively easy in the majority of cases by palpation, röntgenographical examination and proctoscopy. X-rays gave accurate results in a fair majority of the cases but due to the extreme difficulty of filling the sigmoid flexure homogeneously the röntgenologists were sometimes confused by filling defects in normal bowel. The proctoscope allows the growth to be brought into view and permits the removal of a biopsy specimen. By its use the diagnosis was confirmed in almost 100 per cent. of the cases. Its range includes the entire rectum and part of the sigmoid colon and its value cannot be overemphasized.

Pathology.—The tumors commonly assumed the form of an annular constricting lesion, at times ulcerated, at others producing a smooth hard ridge. The growth is thought to begin as a small, tufted proliferation of mucosa later growing in an annular manner to produce the constriction which was found in 59 per cent. of the growths. Ulceration was present in 80 per cent. It has been stated that carcinomas of the ampulla rarely do this, but the author's observations do not support this hypothesis. Annular growths were as common in this location as elsewhere but on account of the greater diameter of its lumen, obstruction rarely followed. Papillomatous tumors, not infrequently present, were indicative of a lower grade of malignancy. Occasionally the direction of growth was toward the perirectal tissues and produced no defect in the lumen. Squamous-cell carcinomas of the anus produced obstruction in a few instances but more often infiltrated the surrounding tissues and skin of the perineum and were seen and palpated on external examination.

Adeno-carcinomas comprised the majority of the histological types. Secondary mucoid degeneration occurred in about one-fourth of the cases. Scirrhous or fibrous carcinomas were twice as frequent in the recto-sigmoid as in the ampulla. Primary mucoid carcinomas were rare, only two occurring in the entire series. The squamous-cell growths were confined to the lower rectum and anus, mainly at and below the mucocutaneous border. The following table distributes 128 tumors in which specimens were obtained into their respective groups:

Histological Distribution

Histological Type	Number of Cases	Percentage
Adeno-carcinoma, all grades	65	50.7
Adeno-carcinoma with mucoid degeneration	31	24.2
Scirrhous carcinoma or carcinoma with fibrosis	20	15.7
Medullary or cellular carcinoma	0	0.0
Primary mucoid carcinoma	2	1.6
Squamous-cell carcinoma	10	7.8
Total	128	100.0

Early metastases were more common from rectal than from colonic neoplasms. Extension to adjacent structures was likewise not uncommon. The appended table shows the location of metastases and extension in the 319 cases.

Location of Extension

Location	Number of Cases	Percentage
Surrounding structures	62	19.4
Special viscera:		
Bladder	16	5.0
Prostate	9	2.8
Sacrum	8	2.5
Pelvis	7	2.2
Vagina	4	1.3
Uterus	2	.6

Location of Metastases

Location	Number of Cases	Percentage
Lymph-glands	83	26.0
Liver	23	7.2
Other locations	17	5.3

Treatment.—Surgery of the rectum is directed along three lines of approach, from the abdominal cavity, from the perineum and a combination of the two. The choice of these is governed chiefly by the location. Tumors of the recto-sigmoid may be removed by the abdominal route alone or by the combined abdomino-perineal method. Those located in the middle portion or ampulla may be removed through the sacral approach or by the combined operation according to the extent of the growth and the judgment of the operator. Tumors of the lower rectum and anus are usually removed by perineal resection although some operators prefer the combined operation in these cases as well.

Abdominal Resection.—This type of operation was used when the growth was high enough to be mobilized through an abdominal incision. It was accomplished in eight cases. The tube anastomosis described by Balfour was used in two cases without apparently influencing the operative mortality. Halsted devised an aseptic technic for end-to-end anastomosis in which the unopened blind ends were sutured together, the diaphragm thus formed being perforated by a long-handled knife passed into the rectum from below and guarded by a rubber shield. Both of the cases in which this method was used, however, died following the operation. The results of abdominal resection alone were as follows:

Results Following Abdominal Resection

Result	Number of Cases	Percentage
Living five years or more	2	25.0
Living less than five years without recurrence	1	12.5
Dead following operation	3	37.5
Dead from recurrence	2	25.0
Total	8	100.0

Combined Abdomino-perineal Resection.—This procedure has become popularized during the past two decades. Originally intended for inaccessible growths high in the rectum, it is now used widely by some operators for all carcinomas of the rectum regardless of location. Various modifications have been developed. Coffey's original procedure was performed in two stages with the idea of reducing shock. Miles contended that with careful preparation the patient could stand the complete operation at one stage, thereby avoiding the toxic effect of the devitalized bowel left at the first stage and omitting one major procedure. Rankin has recently introduced a two-stage operation similar to that of Coffey but for the fact that several weeks are allowed to elapse between the first and second procedures. With this method he reports an operative mortality of 4.3 per cent. on selected cases.

The combined operation has the disadvantage of necessitating a permanent colostomy. The wide perineal defect is slow to heal since primary closure is impossible. The post-operative mortality is, as would be expected, higher than in the less radical procedures but it is now generally agreed that the more radical resection is more efficient from the standpoint of ultimate cure. A distinct advantage of this method and one which is frequently overlooked is the opportunity afforded for exploration of the abdominal cavity. Metastases are frequently detected at the first stage, obviating what might otherwise be a futile resection. The average patient has an extreme distaste for an artificial anus but if properly explained to them, few refuse operation on this account.

It is interesting to compare the results of the operation when done in one and in two stages as illustrated in the following table:

Results of Abdomino-perineal Resection

Result	One Stage		Two Stages	
	No. of Cases	Per Cent.	No. of Cases	Per Cent.
Living five years or more	7	20.0	1	7.7
Living less than five years without recurrence	5	14.3	0	0.0
Dead following operation	11	31.5	5	38.4
Dead from recurrence	9	25.7	3	23.0
Not traced	3	8.6	4	30.7
Total	35	100.0	13	100.0

It must be emphasized that conclusive deductions are impossible from such a small number of cases, but in spite of this some of the figures show a wide divergence. The total number of cases presumably well following the one-stage operation predominated by more than three to one the same cases after the two-stage procedure. The operative mortality was slightly more after the later method. As indicated by this series of cases, therefore, little can be said in favor of the second method since the very result it is supposed to accomplish, namely, a low operative mortality, was increased.

Sacral Resection.—Faget first conceived the idea of removing a portion of the rectum for carcinoma through a sacral incision. Kocher devised a method in which by removing a portion of the coccyx, he obtained better exposure. All sacral operations are more or less modifications of these procedures and that which is commonly known as Kraske's is nothing more than a variation which entails removal of a piece from the left inferior border of the sacrum.

The advocates of the sacral operation claim for it a low operative mortality with preservation of the sphincters in the majority of cases. The results shown by this type of resection in this series indicate that these ends are not always attained. When a sacral anus resulted it was far less satisfactory than an inguinal colostomy. Sphincter control was unsatisfactory in the majority of cases. Abdominal exploration was not permitted and no doubt in a few cases the operation was hopeless in view of a cure. Hence, as would be expected, the immediate mortality was low and the percentage of recurrences high.

Results of Sacral Resection

Results	Number of Cases	Percentage
Living five years or more	5	12.8
Living less than five years without recurrence	4	10.2
Dead following operation	6	15.4
Dead from recurrence	15	38.5
Not traced	9	23.1
Total	39	100.0

The results indicated that the combined operation was by far the most satisfactory in the majority of cases. Under two conditions the sacral operation was thought justifiable. Palliative removal of hopelessly inoperable growths was satisfactorily performed in a few instances. Certain cases in which the abdomen was previously explored have lived several years with normal bowel function. The high proportion of recurrences, however, is influencing surgeons to abandon it in favor of the more radical resection.

Perineal Resection.—A few growths located in the lower rectum and anus could be removed through the perineal route. The operations used were more or less modifications of the Whitehead method. In difficult cases access was facilitated by a combination with the sacral approach. This procedure is applicable only to those cases which are small, movable and located low. A more radical operation was performed in a few instances where the growth was more extensive, especially with carcinomas of the anus. This embodied removal of the entire lower rectum including the anus and sphincters with a cone-shaped portion of the surrounding tissues. While accomplishing radical extirpation the resultant defect was most unsatisfactory.

The disadvantages of the perineal operation are similar to those of the sacral method. Sphincter control was seldom satisfactory. Due to the limited mobility of the involved bowel, perirectal glands were not always re-

TABLE III

Carcinomas of the Rectum

*Results of Treatment**

Result	Dead Following Operation	Dead from Recurrence	Dead from Effects of Carcinoma	Well 5 Years or More	Living Less Than 5 Years, No Recurrence	Not Traced	Total
Inoperable, no operation	0	0	37	0	0	5	42
Inoperable, exploratory laparotomy	0	0	9	0	0	1	10
Inoperable, colostomy	12	0	73	3 (radium)	0	14	102
Inoperable, palliative removal	0	1	1	0	0	2	4
Inoperable, preliminary colostomy	8	0	0	0	0	3	11
Total inoperable cases	20—11.8%	1— 0.7%	120—83.4%	3— 2.1%	0— 0.0%	25—14.8%	169—53.0%
Operable, perineal	1	13	0	1	1	6	22
Operable, sacral	6	15	0	5	4	9	39
Operable, combined one-stage	11	9	0	7	5	3	35
Operable, combined two-stage	5	3	0	1	0	4	13
Operable, abdominal resection	3	2	0	2	1	0	8
Total operable cases	26—22.2%	42—60.9%†	0— 0.0%	16—23.2%†	11—15.9%†	22—18.8%	117—36.7%
Operable, operation refused	0	0	20	0	0	13	33—10.3%
Grand Total	46—14.9%	43—16.6%	140—56.3%	19— 7.3%	11— 4.2%	60—18.8%	319

* The percentages of post-operative deaths are computed on the basis of the entire number undergoing operation.

† The percentages of late results were computed on the basis of the number of operable cases surviving operation and on whom accurate follow-up data were available.

moved and no opportunity was allowed for exploration of the abdominal cavity. Hence deaths from recurrence were high, 59.2 per cent. in actual figures, although the immediate mortality was low. In view of this many operators now prefer the combined operation in one or two stages even for low rectal growths. The results in twenty-two cases were as follows:

Results of Perineal Resection

Result	Number of Cases	Percentage
Living five years or more	1	4.5
Living less than five years without recurrence	1	4.5
Dead following operation	1	4.5
Dead from recurrence	13	59.2
Not traced	6	27.3
Total	22	100.0

The accompanying table summarizes the entire number of cases in regard to the treatment administered and the ultimate results.

Comment.—The prognosis of carcinomas of the rectum will no doubt seem extremely poor when one examines Table III. 53 per cent. of the cases entering the hospital were inoperable and 10.3 per cent. refused operation, leaving only 36.7 per cent. in which resection was carried out. Of this number, 22.2 per cent. died from the effects of the operation. Of the cases surviving operation upon whom accurate follow-up data were available, 60.9 per cent. died from recurrence and 39.1 per cent. were presumably well. The latter number therefore comprises only 9.4 per cent. of all cases observed. It must be remembered, however, that these figures apply to all cases treated during the past forty-two years, a great many of which were admitted at a time when rectal-cancer surgery was undeveloped. However, if the results of an early group of cases are compared with more recent results, the outlook is more hopeful. For example, over a period of five years from 1900 to 1905, 32.4 per cent. of all cases were operable, whereas over a similar period from 1920 to 1925 the operability had risen to 63.5 per cent. The percentage of five-year arrests had risen during the same periods from 25 per cent. to 36 per cent.

It is interesting to note that the operative mortality following resection is lower in the rectum than in the colon. In summarizing the causes of operative deaths it is found that the contributing factors are slightly different. Peritonitis was responsible for the greatest number. Since resection of the rectum is done largely outside the abdominal cavity, deaths from intra-abdominal complications were fewer. On the contrary, the combined abdominoperineal operation is a more formidable procedure and was no doubt responsible for more deaths from shock. The causes of operative mortality in this series are tabulated as follows:

Causes of Operative Mortality

Cause	Number of Cases	Percentage
Peritonitis	16	37.3
Shock	9	20.9
Intestinal obstruction	3	7.0
Pneumonia	8	18.6
Embolus	3	7.0
Cardiac failure	1	2.3
Infection other than peritonitis	1	2.3
Uræmia	1	2.3
Unknown	1	2.3
Total	43	100.0

10.3 per cent. of those cases upon whom operation was advised, refused. The majority of these refusals were based upon the patient's abhorrence of an artificial anus. This has obviously reduced the number of possible cures but with the perfection of the artificial bowel opening, such objections are being over-ruled and many of the patients are being educated to the preference of a colostomy over an almost certain otherwise fatal termination.

The use of colostomy as a pre-operative measure is being valued more and more. Preceding resection of the rectum it has the same advantages as those described under carcinomas of the colon in Part I of this paper. Its use is being similarly restricted to obstructed cases and those whose recovery it is felt will be markedly enhanced thereby.

The use of irradiation in carcinomas of the large bowel has been discussed under carcinomas of the colon. Large growths supposedly adherent to the sacrum are frequently judged inoperable. Rankin has pointed out that this adherence is caused in a great number of cases, not by extension of the tumor itself but by an inflammatory reaction. He further suggested that radium or deep X-rays properly administered might reduce the growth to an operable state. While it cannot be said that irradiation produces a permanent cure, there are no doubt a great many cases whose symptoms could be alleviated by its use. This applies particularly to epitheliomas of the anus which on account of local extension cause a great deal of pain. Many of these have been rendered almost entirely symptom-free and the rate of growth retarded. In view of the poor results of operation in extensive carcinomas of this type, both from the standpoint of difficult removal and the remaining defect, this phase of treatment should be emphasized. Although little hope of an ultimate cure can be promised the patient, the relief of symptoms and the prolongation of life in some cases more than justify its use.

SURGICAL TREATMENT OF RECTAL PROLAPSE

A NEW OPERATION FOR ITS RELIEF

By Arthur A. Salvin, M.D.

of New York, N. Y.

The number and variety of suggestions which have from time to time been offered for the cure of rectal prolapse indicate that no one method has ever been achieved which is thoroughly satisfactory. Nonoperative attempts, such as local applications for the relief of inflammation, injections of astringents beneath the mucosa of phenol, or absolute alcohol, electricity, massage, and mechanical supports, have all been repeatedly tried and proved inadequate.

The operative attempts have been so many and varied that a lengthy paper might be occupied in reviewing them, so that it is possible merely to classify them according to the general type of procedure employed and the principle upon which each is based. Before doing this it may be well to refresh our memory as to the anatomic relations and supports of the rectum and to consider the pathologic conditions which make prolapse possible.

Anatomic Relations of the Rectum

In its normal state the rectum is held in position by three main types of supports which may be designated as (1) passive, (2) active and (3) orthostatic.

Passive support is supplied by certain folds of peritoneum which are reflected away from the walls of the rectum so that they rest in the hollow of the sacrum and in the male upon the bladder, or the vagina in the female. There are also direct fibrous attachments to neighboring organs such as the coccyx, the sacrum and the vagina in the female, and the prostatic capsule in the male. The lateral rectal ligaments are attached to that portion of the pelvic fascia which surrounds the levatores ani muscles.

Active support for the rectum is supplied by the levatores ani muscles, as well as by the sphincter ani.

Still a third type of support is afforded by the position and shape of the rectum itself. From the point where it comes into relation with the prostate in the male or the vagina in the female, the rectum bends abruptly backward, thereafter descending to the anal outlet as a relatively straight tube, as its name (derived from the Latin *rectus*, straight) indicates. The angle formed by this sharp change in direction throws the weight of the pelvic viscera, which would otherwise rest directly upon the rectum, upon the adjacent uterus or bladder (according to sex), making the pressure applied from above vertical only and thereby greatly lessening the strain upon the direct

supports of the rectal tube, which would otherwise be continually exercised by the pelvic content.

Etiology of Prolapse

Anatomically fortified as it is, it would seem impossible for the normally placed and supported rectum to prolapse, which is undoubtedly the case. There is evidence that prolonged wasting disease may reduce the volume and power of the fascial supports, so as to render them functionally inefficient, or that constitutional weakness which is often seen at the two extremes of life, infancy and old age (when rectal prolapse is most common), enfeebles the rectal muscles just as it does those in other parts of the body.

More probable, however, is the theory of congenital insufficiency. Such an anatomic anomaly as an extra long mesorectum or mesosigmoid would certainly tend to permit rectal prolapse, if conditions were otherwise favorable. Some authors have laid particular stress upon abnormal depth of the cul-de-sac of Douglas, which they claim to have observed in every case examined at operation or necropsy. The reasonableness of this suggestion will be seen when we note that an extra deep cul-de-sac would prevent the abrupt angulation of the rectum of which mention was made above and in this way deprive the tube of the vertical position by which it is enabled to avoid undue overhead weight and pressure.

Given such congenital defects, there are a number of exciting causes which may bring about prolapse. Chief among these is undoubtedly constipation, with its attendant straining at stool and long sessions upon the usual high toilet seat compelling defecation in a strained and unnatural position. Less frequent exciting factors may be strains, as from heavy lifting, rectal stricture and new growths such as polyps. But it seems probable that congenital defect must exist before any of these last named factors can become operative.

To cite some of the theories of the more prominent European surgeons: Beresnegowsky and Napalkow are of the opinion that prolapse of the rectum can take place only when the cul-de-sac of Douglas lies very low, at a point which would come beneath a line drawn from the coccyx to the symphysis. Under such circumstances there will be congenital absence of the strong supporting fibres which normally have a place between the prostate and the rectum. V. Esmarch regards the cause of prolapse as a breaking down or loosening of the lower rectal supports, which can be brought about by rectal catarrh, or possibly be the result of undue intraabdominal pressure. Fischl's view is that some inflammatory process brings about an edema of the submucosa, which loosens up the connections between mucosa and submucosa, causing the mucosa to sag downward, eventually bringing other tissue structures with it. Jeannel's [1] view is the precise opposite of those just cited, inasmuch as he believes prolapse is the result of a giving away of the *upper* attachments. As proof of this he cites the fact that one can sever the sphincter muscles entirely without inducing prolapse, but even if the patient

has "the best sphincter in the world" when the upper attachments are destroyed or weakened, prolapse may take place. He compares the rectum to a prisoner chained within his cell. So long as this chain, which typifies the upper attachments, is unbroken, even if the door of the cell be open, the cell door typifying the sphincter, the prisoner cannot get away. But once let the chain be broken by any chance or accident, the prisoner (rectum) can then easily escape.

The etiologic view of most recent writers is that rectal prolapse is really median perineal hernia. K. Ludloff[2] directs attention to the anatomic fact that normally the rectovesical space is distinctly separated from the sacrum, but that when intraabdominal pressure is excessive it may come about that the peritoneum in this space will be drawn forward into the space between the sacral bone and the pelvic diaphragm, and be crowded against the anterior pelvic wall, a position normally occupied by fatty tissue. This produces an "inner hernia." As intraabdominal pressure increases, the anterior wall of the pars pelvina recti may be pressed down until it occupies the cleft in the floor of the pelvis. Such an outcome is still further favored by the weakened muscular contraction of the rectum due to the same exertion of intraabdominal pressure. The rectovesical space becomes deepened and filled with loops of intestines (hedrocele). This increases the pressure upon the rectal wall until it protrudes and, when the resistance of the sphincters is overcome, appears externally as a prolapse.

Accordingly, it is the anterior wall of the pelvic portion of the rectum that protrudes first and under contributory circumstances gradually develops into a complete prolapse.

In several cases of incipient prolapse I could convince myself of the truth of this observation. Even in cases of more pronounced prolapse, the procidentia of the anterior wall is more pronounced than that of the posterior wall, suggesting that the anterior part of the rectal wall drags along the posterior part until the entire circumference is drawn outward. Zuckerkandl[3] is in agreement with this opinion.

The conception that rectal prolapse is a sliding perineal hernia is well explained and propounded in America by Alexis V. Moschcowitz.[4]

It is, however, argued by Lynch,[5] that if Zuckerkandl, Moschowitz and others who uphold their anatomic views are correct in believing the cause of rectal prolapse to be a hernial protrusion, "then in all the cases the opening would be posterior and inside the anus, the prolapse forming an almost complete circle. But it is well known that in the majority of cases the opening is central, which argues against an anterior hernia; at least in cases in which the prolapse is pronounced, with a central opening." The textbook issued from the Mayo Clinic by Rankin, Bargen and Buie,[6] claims that the Moschcowitz designation of the condition as a "sliding hernia" is correct. It is important to remember that prolapse is possible only when the pouch of Douglas is very low. Whether it is to be regarded as a state of infantil-

ism as believed by Bardenheuer-Sonnenschein,[7] or acquired, according to Ludloff,[2] its presence is a *conditio sine qua non.*

The present situation in regard to the etiology of rectal prolapse has been well summed up in the section relating to this subject in Kirschner and Nordmann's Chirurgie.[8] "We must, therefore, consider prolapse of the rectum as the result of several factors working together, some part of which may be congenital and some acquired. The rôle played by any particular one of these factors may vary from one case to another. We cannot postulate any single cause which is operative in all cases."

Types of Operation Heretofore Employed

A survey of the operative methods used both in the past and at present shows that they fall into five general classes:

(I) Those which reduce the size of the anal opening and also of the lower end of the rectal tube itself.

(II) Those strengthening the rectum's natural supports (myorrhaphies, rectopexies).

(III) Those directed especially toward the rectum's natural fixation apparatus (colopexies).

(IV) Those excising the prolapsed portion of the rectum.

(V) Those obliterating the cul-de-sac of Douglas.

The first class of procedure includes cauterization of all types, either chemical or physical; elliptical resections of the rectal mucous membrane with sutures, which may be described in seamstress's parlance as "taking gores" in the mucosa, principally illustrated by Delorme's[9] procedure; wedged-shaped resection of the posterior rectal wall and part of the sphincter; later suturing as in the previous plan, done by Deiffenbach in the first half of the nineteenth century and revived by Roberts in our own day; Thiersch's introduction of a silver wire beneath the skin about the sphincter with the idea that it would be permanently enclosed by the tissues and lend them additional support; Gersun's method of twisting the rectum so as to change its relation to the intraabdominal pressure exerted from above, and likewise, the same operator's suggestion to narrow the aperture by paraffin injections; and finally, removal of the entire mucosa from the outer cylinder of the prolapsed portion of the rectum, with subsequent "reefing" of the submucous tissue to strengthen the external sphincter, later suturing the mucosa to the integument, as practiced by Bier. All these are wrong in principle because they attack the consequences and not the causes of the prolapse. The enlargement of the anus is a secondary development and its atonic condition due to overstretching by the prolapsed gut. To repair this will not prevent recurrence.

The second group of methods designed to strengthen the rectum's natural supports are carried out further up the rectum, but have the same general aims. Hoffmann and Poppert made an H-shaped incision behind the anus; the uprights of the H were then stretched so as to form an anteroposterior

denudation, and the entire opening was stitched with both deep and superficial sutures. Beresnegowsky[10] and Ott used plastic methods—the first devising a muscle plastic from the glutei, and the second performing an inverted perineal plastic. Napalkow made a transverse incision in front of the anus, through which he reached and closed off the peritoneum and then sutured the levatores ani together, reefing them with sutures if they appeared redundant. Those procedures which are carried out upon the posterior wall of the rectum, such as the resection of the coccyx practiced by Verneuil and Gerard Marchant or the sacral suture of Elkhorn, are obviously inefficient, as the posterior wall is never concerned in rectal prolapse.

Fixation of the rectum to the sacrum and coccyx by packing with gauze to obliterate the space with granulation tissue was practiced by Mummery in England and Tuttle in our own country. However, this posterior fixation of the rectum is never very firm. Besides, the patient must remain confined to bed for one month and defecate in the recumbent position for two months.

Other methods which have attained popularity abroad may be briefly cited:

Popenel's[11] method: Dorsal median longitudinal section in the posterior raphé; coccyx temporarily disarticulated, and freed from soft parts; muscle-splitting in levator ani and fascia propria recti. The rectum is narrowed by setting in three transverse sutures, a wire suture being passed through all layers of the rectal wall and attached to the sacrum, wherein two holes are bored for its reception. For the second stage of the operation the patient is placed in the lithotomy position, and a curved incision, 8 cm. long and 2 cm. in front of the anus (transversely to the raphé) is carried through skin and subcutaneous tissues. The tissues between the sphincter and the bulbocavernosus muscle are separated by blunt dissection, which is carried forward toward the pelvis, keeping close to the sphincter until the median border of the levator ani muscles is attained. These muscles are usually much weakened because of the prolapse. The main point in this procedure is the uniting of the prolapsed and weakened muscles and their fascia by three strong silk sutures. These are fixed transversely to the rectum, the operator being obliged to exercise great care not to injure adjoining organs and structures, prostate, etc.

The method advocated by Beresnegowsky[10] is a plastic one, the prolapse being supported and the rectal tube narrowed by the help of folds from the gluteus maximus. Katholicky and Schoemaker operated in a similar manner, but all these procedures are rather complicated, and no more successful than simpler measures.

Employing laparotomy, Lynch's[5] procedure consists in cutting both leaves of the mesentery close to the bowel, through a median incision, care being taken not to injure the blood supply. This incision is carried across between the rectum and the uterus in the female, and the rectum and bladder in the male. The peritoneum of both mesentery leaves in the cul-de-sac region is dissected back, so as to expose the lateral ligaments. With the pelvic colon

and rectum mobilized and held taut, the lateral ligaments are shortened by two or three interrupted sutures. The peritoneum is then sutured to the top of the pelvic colon and the opening between it and the bladder (or uterus) closed, forming a new pelvic peritoneal diaphragm and obliterating the cul-de-sac. The weight being equally distributed over the pelvic diaphragm, recurrence of the prolapse is prevented. Sometimes it will be necessary to suture the bowel to the broad ligament at the back of the uterus.

A procedure similar in principle but by the dorsal route was designed by Maes and Rives,[12] independently of Lynch. They operate through an inverted-Y incision, the arms embracing the anus, which is deepened to expose the external sphincter. The anterior quadrant of this sphincter is incised and sutured end-to-end with U-sutures. Dissection is continued until the superior surface of the levator ani, covered by pelvic fascia, forms the lateral wall of the exposed cul-de-sac. Sutures are now introduced to approximate the levatores and suspend the rectum. "A deep bite is taken in the levator and fascia on the right, several transverse stitches are taken across the lateral and anterior aspects of the rectal walls, at a point on the left levator corresponding to the first bite on the right, a similar stitch is taken. Three or four stitches of the same type are taken at short intervals until the free margins of the levatores are reached. Each of these sutures, when tied, approximates the levatores ani, suspends and plicates the rectum, and closes the depth of the cul-de-sac. A last suture approximates the free margins of the levatores but does not pick up the rectum. This permits the anus to be thrown backward, reproducing the normal backward angulation of the anal canal." A similar operation was described by Duval and Lenormant,[13] in 1904.

The second type, rectopexies, are not efficient because they again do not attack the causes of the prolapse. Fixation of the posterior wall of the rectum is not sufficient to correct the condition, nor is the narrowing of the rectum.

In the third group there is such a wide variety of procedures as to forbid even mention of them all. Jeannel's[1] plan involved the formation of an artificial anus, suturing the sigmoid to the anterior abdominal wall and thus suspending the distal part of the bowel. Piotr A. Herzen,[14] in Moscow, fixed the sigmoid to the anterior abdominal wall after having performed an anastomosis between the afferent and efferent loops of the colon sigmoideum. Von Eiselsberg[15] resected the sigmoid prior to its fixation to the abdominal wall, as did with certain modifications Ludloff, Friedrich and others. All these operations neglect entirely the lower part of the rectum, which really prolapses and is neither sufficiently elevated nor supported by the suspension of the sigmoid.

In the fourth group the operation devising the resection of the mucosa of the prolapsed rectum followed by plication of the muscularis was first described by Rehn in Germany and later by Delorme[9] independently in

France. It is very efficient in cases of prolapse not longer than three to four inches, if the floor of the pelvis is not otherwise weakened.

Of the operations of the fourth group, excision, that of Mikulicz[16] is probably the best known. He removed the prolapse with knife and scissors, closed the anterior cul-de-sac and sutured the outer inner portions of the prolapse together at the line of section. Though this plan has been followed with various modifications for a long time, it has been well characterized by Maes,[12] who says: "It is an illogical procedure at best, since none of the supports are restored and since further prolapse is inhibited only by the mesosigmoid. The normal motor mechanism of the rectal pouch is, of course, entirely destroyed, wound infection, gangrene of the gut and peritonitis are not uncommon sequellae, and recurrence is estimated to be as high as 54 per cent, so that the technic, on the face of it, has little to recommend it."

In the fifth group, several procedures are founded upon the conception of rectal prolapse as depending upon the low position of the cul-de-sac of Douglas. Such is the Bardenheuer-Sonnenschein operation, which consists of median laparotomy and ventral fixation of the uterus, replacement of the prolapse, and obliteration of Douglas' cul-de-sac by sutering together the two folds of peritoneum. A loop formed by the sigmoid flexure is brought over transversely in front of the sacrum, and so slung that its descending portion is parallel to the linea innominata dextra behind uterus and adnexa. The ascending portion of this loop is now sutured to the peritoneum and the periosteum of the sacral bone, and also to the right synchondrosis and right wall of the pelvis. The descending part of the loop is fixed to the left fold of the ligamenta lata and the peritoneum behind the uterus, as well as to the left wall of the pelvis. The pouch of Douglas is thus fully obliterated. In order to prevent adhesions between the two branches of the loop, sutures are placed in such a way as to bring the appendices epiploicae between them.[8]

Moschcowitz's[4] operation has found continually growing favor, and several modifications have been devised. His technic consists in a median abdominal incision, extending from symphysis pubis to umbilicus, the patient being placed in the Trendelenburg position after the abdomen is opened. The rectum is pulled up and held taut. In women, Pagenstecher or silk sutures are passed about the cul-de-sac and tied, the sutures being placed for as great a distance as the peritoneum can be brought together, thus practically obliterating the pouch. The sutures which are near enough to be attached to the cervix or body of the uterus are anchored to these structures, while those approaching the rectum are caught to the rectal serosa, care being taken to make the stitches close and firm and to avoid most scrupulously inclusion of the ureters or the internal iliac vessels in the suture line. There is no fixation of the lower bowel itself.

Bardenheuer's and Moschcowitz's operations do, of course, obliterate Douglas' pouch. But Moschcowitz's own words suggest some dissatisfaction with this operation, as he says: "Theoretically it would be better to split the peritoneum in the depth of the cul-de-sac and to suture the fascia first. I

have attempted to do so in one case, but I found the procedure so difficult that I abandoned it."

After reading the foregoing review it may appear presumptuous of the present author to bring forward another method claiming advantages not found in any of the procedures mentioned. It is far from his intention to claim superior skill or unrivaled knowledge of pathologic anatomy. In the case about to be reported, the standardized methods of treating prolapse of the rectum did not seem applicable. Certain modifications proved necessary. Because these measures have been successful in one case, it seems worthwhile to describe them. Other surgeons must estimate their merits.

Case Report.—A woman, aged fifty-eight years, was admitted to Sydenham Hospital April 15, 1931, with the complaint of prolapse of the rectum, forming a protrusion of about four inches. The condition had been present for about three years. Operation had been done at another hospital on October 11, 1930, six months previously; but the condition had been aggravated instead of improved, so that when I saw her she was unable to stand or walk because of the prolapse, which was practically irreducible. The anus was relaxed, open and atonic; the prolapsed portion of the gut, edematous and congested. Incontinence of feces and flatus surrounded her with such an offensive odor that the unfortunate woman was completely shut off from social intercourse.

On April 16, 1931, I performed the Rehn-Delorme operation. Through an incision exactly at the mucocutaneous juncture, the mucosa was separated from the very friable tissues by sharp dissection, all bleeding points being carefully clamped and ligated. On all sides, longitudinal sutures of chromic catgut were set in at equal distances, starting at the mucocutaneous line and reaching the apex of the prolapsed gut. The tightening of these sutures pleated the bowel wall and drew the prolapse back into the pelvis. A few auxiliary plicating sutures were set in to retain the gut firmly in position. All redundant mucosa was cut away from the apex of the prolapsed portion and the mucocutaneous line restored by suturing the trimmed edge to the skin. A rectal tube wrapped in vaseline gauze was left in the rectum.

Recovery was prompt and entirely satisfactory, the patient being discharged from the hospital on the eighth postoperative day. She remained well for six months; but thereafter the condition recurred, so that she was reduced to a state practically as intolerable as before the Rehn-Delorme operation. The plication did not give way; but prolapse developed higher up in the colon—the condition which Jeannel[1] has described as prolapse of the invaginated colon.

On May 15, 1932, the patient entered the Central Park Hospital for operation. The procedure employed, while belonging to the general class of operations originated in Germany by Bardenheuer and practiced by Quenu and Duval[17] in France and by Moschcowitz in America, has certain features which were added for the first time, and which proved so useful to me that I venture to hope others may be helped by them. It is carried out far from the ureter and the internal iliac vessels so that possible injury to these structures is avoided, a misfortune which might have marred many otherwise satisfactory results with previous interventions.

Author's Technic.—With the patient in the high Trendelenburg position, a left paramedian abdominal incision was extended from the symphysis to the level of the umbilicus. The uterus was elevated and fixed to the anterior abdominal wall. The recto-uterine peritoneal reflection was incised transversely, two lateral longitudinal incisions extending through the rectal serosa into the mesorectum. The rectum was dissected from the vaginal septum and the sacral excavation, and its perineal and sacral flexures mobilized. Using Pagenstecher sutures, the rectum was attached to the left lateral posterior aspect of the ventro-fixed uterus, well up and across to the right side.

Fig. 1.—January, 1933, about eight months after operation. Shows the firm fixation of the transplanted rectum.

Fig. 2.—December 27, 1933. Shows the unchanged position of the transplanted rectum.

Fig. 3.—December 27, 1933. Shows the mobility of the lower, non-fixed sigmoid, being filled out. There is no obstruction whatever.

A few more sutures fixed the middle part of the sigmoid to the anterior abdominal wall, the lower part of the sigmoid for a distance of three or four inches being left entirely free of sutures. This was done in order to prevent kinking and development of obstruction at the site of fixation of the rectum to the abdominal wall; also to form a defensive barrier, so to speak, against the effect of too great peristaltic activity upon the transplanted rectum.

Postoperative Course.—The patient was kept constipated with deodorized tincture of opium—8 minims, three times daily for seven days, when an enema of five ounces of olive oil was administered. The repetition of this oil enema the following day resulted in a natural bowel movement. Thereafter feces were passed normally every day and the patient's condition has continued highly satisfactory. The sphincters function perfectly, retaining both hard and soft stools with no involuntary escape of flatus. In short, normal bowel function has been restored. Roentgenographic examination after a barium enema on January 27, and December 27, 1933, demonstrate the anatomic relations of the rectum and colon (Figs. 1, 2 and 3).

Comment

The satisfaction of this patient at present, compared with her desperate condition after the first and second interventions, is the best comment possible upon the success of the foregoing technic. While it must be admitted that the operation as modified is decidedly difficult, it presents definite advantages. The low position of the pouch of Douglas is corrected. The prolapsed rectum is elevated and fixed on its entire length to the anterior abdominal wall, thus preventing the possibility of forming a new protrusion in the anterior wall of the rectum, where according to Ludloff and Moschcowitz the prolapse originates. There is no danger of coming in contact with the ureters or injuring the internal iliac vessels. The method of suturing the transplanted gut to the anterior wall prevents kinking and angulation and possible formation of later intestinal obstruction.

The Rehn-Delorme procedure is useful in primary cases of prolapse, when the protrusion is not more than three or four inches, but proves unsatisfactory in recurrent cases.

In the performance of Delorme's operation, great care must be observed in ligating all bleeding points as one advances. Otherwise hematomas may form and nullify the effects of the operation. Care must also be exercised to avoid incising the walls of the rectum, which are usually very thin, due to the overstretching undergone while prolapsed. On the anterior aspect we must avoid entrance into the peritoneal cavity; on the posterior aspect we must keep out of the mesorectum, where injury to a blood vessel would lead to undesirable complications. Should one be so unfortunate as to do this, however, he must at once enlarge the incision, ligate the injured vessels, and convert the extraperitoneal intervention into an intraperitoneal one.

Summary

An original operation for prolapse of the rectum is described which has given the author more satisfactory results than the customary procedures. It is carried out far from the ureter and the internal iliac vessels, thus avoid-

ing any possible injury to these structures. In the case reported, this technic proved entirely successful after two previous operations had failed.

Patient was seen and examined again in December, 1934, about two years and a half after her last operation. Her condition continues to be perfect.

REFERENCES

[1] Jeannel: Résultat d'une opération de colopexie pour prolapsus invaginé du rectum. Gez. Hebdomanaire, May 24, 1890.

[2] Ludloff, K.: Weitere Beiträge zur Pathogenese und Therapie des Recumprolapses. Arch. f. klin. Chir., vol. 60, p. 715, 1899–1900.

[3] Zuckerkandl, O.: Beiträge zur Lehre von den Brüchen im Bereiche des Douglas' schen Raumes. Deutsch. Ztschr. f. Chir., vol. 31, p. 590, 1891.

[4] Moschcowitz, A. V.: The Pathogenesis, Anatomy and Cure of Prolapse of the Rectum, Surg., Gynec., and Obst., vol. 15, p. 7, 1912.

[5] Lynch, J. M.: A New Operation for Prolapse of the Rectum. J.A.M.A., vol. 89, p. 1050, 1927.

[6] Rankin, F. W., Bargen, J. A., and Buie, L. A.: The Colon, Rectum and Anus. Philadelphia, W. B. Saunders Co., Chap. 16, p. 378, 1932.

[7] Bardenheuer, B.: In Bier, Braun and Kümmell's Chirurgische Operationslehre. Leipzig, J. A. Barth, Bd. IV, 1923.

[8] Reichle, R., and Tietze, A.: Die Chirurgie des Mastdarmes und des Afters. Kirchner-Nordmann, Die Chirurgie. Berlin u. Wien, Urban & Schwartzenberg, Bd. V.

[9] Delorme: Traitement du prolapsus rectal par l'excision de la muqueuse. Gaz. des hôp., No. 74, 1901.

[10] Beresnegowsky, N.: Über die Pathologie und Therapie des Mastdarmvorfalls. Arch. f. klin. Chir., vol. 91, p. 627, 1910.

[11] Popenel: Beitrag zur Radikaloperation des Mastdarmvorfalles, Entralblat. f. Chir., No. 15, 1920.

[12] Maes, U., and Rives, J. D.: An Operation for Complete Prolapse of the Rectum. Surg., Gynec., and Obst., vol. 42, p. 594, 1926.

[13] Duval and Lenormant: Rectoplicature antérieure et myorraphie des releveurs de l'anus dans le traitment du prolapsus rectal. Revue de Chir., No. 5, 1904.

[14] Herzen, P. A.: Wiestnik Chir., 1901, No. 20, as quoted by Beresnegowsky.

[15] von Eiselsberg, A.: Zur operativen Behandlung grosser Rectumprolapse. Verhandlungen der Deutsch. Gesellsch. f. Chir., vol. 31, p. 157, 1902.

[16] Mikulicz, J.: Zur operativen Behandlung des Prolapsus recti et coli invaginati. Arch. f. klin. Chir., vol. 38, p. 74, 1889.

[17] Quenu, E., and Duval, P.: Technique de la colopexie pour prolapsus du rectum. Rev. de Chir., vol. 41, p. 135, 1910.

OSTEOCHONDRITIS OF THE GROWTH CENTERS

By Lewis M. Overton, M.D.

of Rochester, Minn.

from the Mayo Foundation

The clinical entity which recently was given the name of osteochondritis of the growth or ossification centers has been the subject of discussion by numerous authors for the last three decades. During this time, there have appeared in the literature about 700 reports. Only a few of the authors, all of whom wrote within the last decade, have mentioned that the disease is a similar process in all epiphyses, but that it occurs in each epiphysis at the age period of its most rapid growth. One of the purposes of this study will be to demonstrate that all of these lesions are manifestations of one and the same disease; a fact which is now recognized by only a few writers.

Müller,[14] in 1888, was probably the first to describe several conditions in various epiphyses which can now be looked on as similar conditions occurring at different age periods, and bearing all the characteristics of osteochondritis. No other reports appeared in the literature until Osgood,[15] in 1903, gave the original description of a lesion of the tibial tubercle. Later, Schlatter,[20] unaware of Osgood's work, described the same condition. Köhler,[10] in 1908, described tarsal scaphoiditis. Legg,[11] in 1909, wrote on a peculiar affection of the hip and distinguished the condition from tuberculosis of the hip-joint, and in the following year, Calvé[3] and Perthes[16] also described the same condition. It was not until 1913 that Perthes[17] gave his classical description and since that time the disease has been known generally by his name. Sever,[22] in 1912, reported a similar disease of the os calcis which he termed apophysitis. Freiberg,[5] in 1914, described a disease of the epiphysis of the head of the second metatarsal bone to which he gave the name of infraction. Scheuermann,[19] in 1921, first described vertebral epiphysitis. Calvé,[4] in 1925, described a lesion of the vertebral body which he called osteochondritis. Harbin and Zollinger,[7] in 1930, gave the most complete review of the literature that has been published up to this time.

Various factors have been offered or denied as causes of the condition under consideration: heredity,[7] congenital anomaly,[8] endocrine disturbance, rickets,[2] infection,[9, 18] and trauma.[12, 17, 19, 21, 23]

Pathology.—Analysis of the findings reported[1, 6, 9, 13, 18, 23, 24] would tend to make one believe that the pathology of osteochondritis is variable. However, if one considers the general health and physical condition of patients who suffer from the disease, the problem of interpreting the pathologic findings should be simple. These patients do not present a clinical picture of tuberculosis or of any other infectious condition, and when an infection is found, it must be secondary. On the other hand, the pathologic finding of

aseptic necrosis is in keeping with the good physical condition and clinical findings of these patients.

CASE I.—A girl, aged five and a half years, weighed thirty-four pounds (15.4 kg.) and was four feet (122 cm.) tall. She was brought to the clinic November 24, 1930, with a complaint of curvature of the thoracic and lumbar portions of the spinal column. The past history of the patient, as well as the family history, was negative. The spinal deformity had begun at the age of three and a half years, and had progressed gradually since that time. There were no other symptoms.

General examination gave negative results, except for caries of the teeth and infected tonsils. There was scoliosis of the thoracic portion of the spinal column, to the right, and of the lumbar portion, to the left. Röntgenologic examination revealed wedging of the ninth, tenth, and eleventh thoracic vertebræ on the left, and of the ninth and tenth anteriorly.

Treatment consisted first of exercising and stretching the spinal muscles for three to four days, and second, of application of a body plaster-of-Paris case, with the patient in the stretched position. January 20, 1931, this case was removed and a new one applied. The röntgenogram at this time showed the spine to be straighter, but the vertebral lesions were unchanged. March 28, 1931, the plaster case was removed and a Taylor back brace was applied. There was continued improvement in correction of the deformity, but röntgenologic examination did not give evidence of change. The subsequent course of the disease in this case is not known.

CASE II.—A girl, aged twelve years, weighed eighty-seven pounds (39.5 kg.). She was admitted to the clinic April 1, 1931, with a complaint of a limp that had been present since her second year of life. At that time, it had been learned that she had a congenital dislocation of the right hip. There were no symptoms relative to the back. Examination revealed an old, congenital dislocation of the right hip, with shortening of the extremity by two inches (5 cm.). Attention was called to the spine because of the presence of kyphosis. The röntgenogram gave evidence of typical osteochondritis involving the mid-thoracic vertebral epiphyses.

The patient was brought to the clinic only for an opinion concerning the condition of the hip and did not remain for treatment. Her guardians were advised to arrange for corrective exercises for the spinal deformity. If the deformity progressed, they were told, the girl should wear some type of support for the back.

CASE III.—A boy, aged fourteen years, was first admitted to the clinic August 26, 1926, because of sinus trouble, which promptly cleared up. January 3, 1931, he was brought to the clinic again, because of backache and round shoulders. The trouble had begun about six months after his dismissal from the clinic in 1926. At that time, slowly progressive lower thoracic and upper lumbar kyphosis had developed, associated with frequent and severe backache. In July, 1930, the patient was placed on a Bradford frame and Buck's extension was applied for five weeks, after which he was allowed to be out of bed, wearing a Taylor back brace. He has worn the brace constantly since that time, with resultant partial correction of the kyphosis, but he has obtained no relief from the pain.

The boy was well developed and apparently was in good health. There was definite kyphosis from the eighth thoracic vertebra to the second lumbar vertebra. All motions of the spinal column were limited. There was spasm of the lower muscles of the back. Röntgenologic examination disclosed increased density and irregularity of the anterior epiphyses of the lower thoracic vertebra, with a slight wedging of the bodies anteriorly.

The patient was allowed to return home, wearing a Taylor back brace, and his guardians were instructed to bring him again if there was no improvement in his condition. March 30, 1932, he returned because the pain had become much more severe. Röntgenograms at that time gave evidence of some progression in the fragmentation of the lower thoracic vertebral epiphyses. Arthrodesis of this region of the spinal column

was performed by means of an Albee bone graft, which resulted in relief from all symptoms.

CASE IV.—A boy, aged sixteen years, weighed 200 pounds (91 kg.) and was seventy-one inches (180 cm.) tall. The patient was admitted to the clinic September 13, 1930, with a complaint of pain in the thoracic region of the back, which had been present for two months. He gave a history of an injury which had been incurred at football practice in the spring of 1930. He had been dazed for a few minutes after the injury, but had had no further trouble until a few days later, when pain had developed in the thoracic region of the spinal column; the pain was increased on movement of the arms. Radiant heat had been applied to the back for a few days and all symptoms had disappeared. The boy had had no further trouble until two months before his admission, when he had lifted two traveling bags. This exertion had produced girdle pain in the lower thoracic region. Since that time, he had had pain low in the thoracic region of the spinal column, which had been projected around the costal margins on both sides.

The boy appeared to be in good general health; he was well developed, and considerably overweight. There was slight lower thoracic kyphosis. Röntgenologic examination gave evidence of osteochondritis of the seventh, eighth, ninth, and tenth thoracic vertebral epiphyses, with slight wedging anteriorly of the eighth and ninth thoracic vertebræ.

The boy was instructed to wear a Taylor back brace, which gave relief, and was told to return in three months. Reëxamination, December 19, 1930, disclosed very little change on röntgenologic examination, but all symptoms had disappeared. The patient was then allowed to go without the brace, and returned March 30, 1931, having been perfectly well since discarding the brace. The röntgenogram at this time gave evidence that the lesions in the spine were healing but the deformity persisted. The patient has had no further symptoms.

CASE V.—A woman, aged eighteen years, had been admitted to the clinic first on August 12, 1919, when she was aged seven years, because of septic tonsils; these were removed. When she returned, September 4, 1930, she complained of pain in the right foot, in the region of the second metatarsal head; the pain had been present for one year.

The patient was well developed, well nourished, was in good general health, and was moderately overweight. There was some thickness and tenderness in the region of the head of the second right metatarsal. The röntgenogram revealed flattening and broadening of the head of the second metatarsal. There was also fragmentation of the head, with irregular areas of increased density and other areas of decreased density. The patient returned March 2, 1931, because symptoms had become progressively worse. Röntgenologic examination at this time disclosed more marked fragmentation of the head of the second metatarsal on the right. The weight was taken off the diseased head by supports and the condition gradually improved.

Further examination, December 30, 1932, revealed that the patient was having slight pain only after strenuous exercise. At this time, the diseased epiphysis had undergone considerable repair, although evidence of fragmentation was still present.

CASE VI.—A boy, aged six and a half years, weighed forty-six pounds (20.8 kg.). He was admitted to the clinic July 9, 1925, because of abnormality of the left hip, which had begun as an acute pain in April. At the time of onset of the disease the child had been confined to bed for three days. After the acute pain had subsided, he had returned to school. Since that time, he had cried occasionally at night, and had a limp. There had been no pain since the acute symptoms had subsided. There was no history of injury and there had not been any fever.

The child was well developed. Examination gave negative results, except for infected tonsils. All movements of the left hip were good. Röntgenograms of this hip gave evidence of slight flattening, roughening, and fragmentation of the capital epiphysis

of the femur (Fig. 1). A spica plaster-of-Paris case was applied and a régimé including a prescribed diet and fresh air was ordered.

October 15, 1925, the patient returned, at which time he had gained weight and made no complaint. The röntgenogram gave evidence of progression of the disease.

FIG. 1.—(Case VI.) Osteochondritis of the growth centers; three months' duration.

FIG. 2.—(Case VI.) Osteochondritis of the growth centers; eighteen months' duration.

There was more fragmentation, more flattening, and irregular areas of decreased density and other areas of increased density, with moderate absorption of the epiphysis. The spica plaster-of-Paris case was reapplied and the right shoe was elevated to prevent weight-bearing on the left leg.

January 18, 1926, the child was brought back again, when another spica plaster-of-

FIG. 3.—(Case VI.) Osteochondritis of the growth centers; thirty-three months' duration.

FIG. 4.—(Case VI.) Osteochondritis of the growth centers; sixty months' duration.

Paris case was applied. The röntgenogram at this time gave evidence of further progression of the lesion in spite of the fact that there had been no weight-bearing on this extremity. The epiphysis was markedly fragmented. There were irregular areas of increased density and other areas of decreased density, associated with marked flattening

and considerable absorption of the upper two-thirds of the epiphysis. There was also some absorption of the neck of the femur, with resultant shortening and broadening.

Further examination, April 19, 1926, showed that slight healing had begun in the lower half of the epiphysis. There had been slight reposition of bone in both the epiphysis and the adjacent neck. It was evident that the stage of fragmentation and absorption had passed and the epiphysis had begun the stage of repair.

Observations made thereafter (Figs. 2, 3 and 4) revealed that the epiphysis was healing slowly. There was gradual, but progressive reposition of bone; but the deformity remained unchanged. Improvement was very slow, and a spica plaster-of-Paris case was worn until July 17, 1928, at which time it was removed and use of crutches was begun. March 20, 1929, the child was given a Thomas caliper walking splint which was worn until September 16, 1929. The patient was dismissed, with the lesion apparently completely healed, May 15, 1930. At that time there was slight shortening of the extremity, with slight limitation of abduction, but no symptoms. General health of the boy was excellent.

Comment.—The failure of most authors to recognize osteochondritis of all epiphyses as evidence of one disease may be explained on the basis that the nature and cause of the disease was not clearly understood. Careful study of the uncomplicated cases will reveal that they are similar in the different epiphyses. The history, physical findings, röntgenograms, laboratory findings, and clinical course are similar in most cases.

No satisfactory explanation of the cause of the disease has been made. As a result of careful review of the literature, and analysis of the cases presented in this study, the following theory may be suggested:

Osteochondritis of the growth centers is due to insufficient nutrition of the epiphysis resulting from a demand which is greater than the physiologic supply.

This theory is based on the knowledge that the disease occurs in each epiphysis at the age period when that epiphysis is in the stage of most rapid growth. At this time the vascular system is taxed to its physiologic limit in supplying the needed nutrition to the epiphysis. Should there arise a demand for increased nutrition, which in turn would require increase in the circulatory supply to the epiphysis, imbalance would be produced; that is to say, the demand would be greater than the supply. When this state is reached, it is logical to assume that the epiphysis is not being properly nourished. As a result of the improper nourishment, anemia occurs in that part of the epiphysis which normally has the least supply of blood; namely, the central subchondral zone. The anemic portion subsequently undergoes a degenerative change, manifesting itself as aseptic necrosis. The patient usually continues to use this diseased epiphysis for weight-bearing or other normal activities, with the result that the thin shell of bone surrounding the necrotic portion breaks down, producing the so-called fragmentation which is always seen in these cases. At this stage, the patient usually consults a physician.

The disease most frequently afflicts healthy, active, moderately overweight children, during their period of rapid development. The epiphyses of these children are growing more rapidly than those of the more slowly developing children. The stress and strain of continued activity could easily

produce the disease in an epiphysis which, under ideal conditions, is receiving barely sufficient nutriment for its maintenance and growth.

The findings in the cases presented in this study substantiate the theory which has been suggested. In none of the cases was there any evidence of an infectious process. In only one case was there any history of trauma, and this had occurred about three months before the onset of the symptoms. One patient had congenital dislocation of the hip, but this was the case in which a symptomless vertebral epiphysitis was found. There was neither any evidence of rickets, nor of an endocrine disturbance in any case. One must remember, however, that statistical data obtained from a series as small as the one which forms the basis of this study are not without fallacies. On the other hand, the factors of good health, normal development, and activity must be of some significance when supported by a majority of the cases reported in the literature.

Osteochondritis in almost all cases is self-limited and runs a definite course. As a result, the patients rarely come to operation. For this reason, one has to rely almost entirely on the history, the physical examination, and the röntgenologic findings in making a diagnosis. The röntgenogram is usually so typical that little difficulty is encountered in arriving at the correct diagnosis. The picture shows alternating areas of rarefaction and increased density, flattening, broadening, and fragmentation of the epiphysis; moreover, if the femoral head is involved, there is also thickening and shortening of the neck. During the usual course which the disease runs, the epiphysis heals completely, but there remains the deformity of flattening and broadening of the epiphysis.

CONCLUSIONS.—(1) The lesion is similar in the various epiphyses, but occurs in each epiphysis during its most active period of growth.

(2) The disease most commonly affects healthy, well developed, active patients.

(3) The etiology of the disease has never been definitely proved. However, the theory suggested in this study is that when the demand of the epiphysis for nourishment is greater than the supply, nutrition of the epiphysis is insufficient.

(4) The pathologic change consists in aseptic necrosis, with secondary fragmentation and deformity of the epiphysis.

(5) The diagnosis of the disease is based entirely on the clinical and röntgenologic findings, because the disease is self-limited, and surgical intervention is rarely required.

REFERENCES

[1] Axhausen, G.: Der anatomische Krankheitsablauf bei der Koehlerschen Krankheit der Metatarsalköpfchen und der Perthesschen Krankheit des Hüftkopfes. Arch. f. klin. Chir., vol. 124, pp. 511–542, 1923.

[2] Buchman, Joseph, and Gettleman, I. F.: Inorganic Blood Chemistry in the Osteochondritis. Am. Jour. Dis. Child., vol. 40, pp. 1250–1261, December, 1930.

[3] Calvé, Jacques: Sur une greffée sur des défermations caractéristiques de l'extrémité supérieure du fémur. Rev. de chir., vol. 42, pp. 54–84, July, 1910.

[4] Calvé, Jacques: A Localized Affection of the Spine Suggesting Osteochondritis of the Vertebral Body with the Clinical Aspect of Pott's Disease. Jour. Bone and Joint Surg., vol. 23, pp. 41–46, January, 1925.

[5] Freiberg, A. H.: Infraction of the Second Metatarsal Bone. Surg., Gynec., and Obst., vol. 19, pp. 191–193, August, 1914.

[6] Greenwood, H. H.: The Relationship of Tuberculosis to Köhler's Disease. Brit. Jour. Surg., vol. 15, pp. 245–249, October, 1928.

[7] Harbin, Maxwell, and Zollinger, Robert: Osteochondritis of the Growth Centers. Surg., Gynec., and Obst., vol. 51, pp. 145–161, August, 1930.

[8] Jansen, Murk: On Coxa Plana and Its Causation. Jour. Bone and Joint Surg., vol. 21, pp. 265–277, April, 1923.

[9] Kidner, F. C.: An Unusual Case of Legg-Perthes' Disease. Jour. Bone and Joint Surg., vol. 24, pp. 565–569, July, 1926.

[10] Köhler, Alban: Ueber eine häufige bisher anscheinend unbekannte Erkrankung einzelner kindlicher Knochen. München. med. Wchnschr., vol. 2, pp. 1923–1925, September 15, 1908.

[11] Legg, A. T.: An Obscure Affection of the Hip-joint. Boston Med. and Surg. Jour., vol. 162, pp. 202–204, February 17, 1910.

[12] Lippmann, R. K.: The Pathogenesis of Legg-Calvé-Perthes' Disease Based upon the Pathological Findings in a Case. Am. Jour. Surg., vol. 6, pp. 785–791, June, 1929.

[13] Mau, C.: Tierexperimentelle Studien zur Frage der pathologischen Anatomie der Adoleszenten Kyphose. Ztschr. f. orthop. Chir., vol. 51, pp. 106–125, 1929.

[14] Müller, Ernst: Ueber die Verbiegung des Schenkelbalses im Wachstumsalts. Beitr. z. klin. Chir., vol. 4, pp. 137–148, November, 1888.

[15] Osgood, R. B.: Lesions of the Tibial Tubercle Occurring During Adolescence. Boston Med. Jour., vol. 148, pp. 114–117, January 29, 1903.

[16] Perthes, Georg: Über Arthritis deformans juvenilis. Deutsch. Ztschr. f. Chir., vol. 107, pp. 111–150, October, 1910.

[17] Perthes, Georg: Ueber Osteochondritis deformans juvenilis. Arch. f. klin. Chir., vol. 101, pp. 779–807, June 17, 1913.

[18] Phemister, D. B.: Operation for Epiphysitis of the Head of the Femur (Perthes' Disease). Arch. Surg., vol. 2, pp. 221–230, March, 1921.

[19] Scheuermann, H.: Kyphosis dorsalis juvenilis. Ztschr. f. orthop. Chir., vol. 41, pp. 305–317, 1921.

[20] Schlatter, C.: Unvollstandige Abrissfrakturen der Tuberositas tibiae oder Wachstumsanomalien. Beitr. z. klin. Chir., vol. 59, pp. 518–546, September, 1908.

[21] Schwarz, Erwin: Eine typische Erkrankung der oberen Femurepiphyse. Beitr. z. klin. Chir., vol. 93, pp. 1–61, July, 1914.

[22] Sever, J. W.: Apophysitis of the Os Calcis. New York Med. Jour., vol. 95, pp. 1025–1029, 1912.

[23] Zemansky, A. P.: The Pathology and Pathogenesis of Legg-Calvé-Perthes' Disease. Am. Jour. Surg., vol. 4, pp. 169–184, February, 1928.

[24] Zemansky, A. P., and Lippmann, R. K.: The Importance of the Vessels in the Round Ligament to the Head of the Femur During the Period of Growth, and Their Possible Relationship to Perthes' Disease. Surg., Gynec., and Obst., vol. 48, pp. 461–469, April, 1929.

FRACTURE OF THE EXTERNAL CONDYLE OF THE HUMERUS IN CHILDREN

By James Harry Heyl, M.D.

of New York, N. Y.

Some years ago, the writer had an unfortunate experience following excision of a capitellar epiphysis of the humerus in a late case of separation of that epiphysis. It is our purpose primarily to contrast this case with others treated by replacement, and to condemn excision except as a last resort. We are reporting only those cases requiring open operation. There were five cases of separation of the external condyle at St. Mary's Hospital for Children in the last eight years, which required open reduction. Four were replaced and one, six months after injury, was excised.

While epiphyseal separations of the external condyle of slight degree are common, much more so than the literature would lead one to believe, complete separation, usually with rotation of the fragment which precludes closed reduction, is unusual. As a result of its rarity, no one has had a very large experience with complete separation. In addition there has been a tendency to consider epiphyseal separations in childhood with fractures of the capitellum or external condyle in adults. From the point of view of mechanism, pathologic anatomy, and immediate results of operation, this is a perfectly natural and proper attitude. The factors of growth and late results are of such importance, however, that it is quite improper to draw conclusions from the treatment of adults, and apply them to children, particularly in the earlier age groups.

The late results of separation of the capitellar epiphysis are occasionally very unfortunate as regards the function of the injured elbow, deformity, and even ulnar nerve injury. As these end-results appear long after the original injury and treatment, there has been a tendency to overlook the causal relationships, and a failure to appreciate all the factors which enter into a good final result.

Occurrence.—Fractures of the external condyle in children are of frequent occurrence. Supracondylar fractures in most statistics are the most common fractures of the humerus. Treves (153 to 89),[11] Ashurst (29 to 12),[1] and Wilson (82 to 34)[12] found approximately half as many fractures of the external condyle as supracondylar. Stimson found the proportion of his series to be nearly reversed, 45 of the external condyle to 26 supracondylar.[9] Of the total fractures of the external condyle, only a small proportion result in complete separation of the lower fragment with rotation. Treves found nine of 42 cases in which only fibrous union occurred at the site of fracture, which gives a rough indication of the occurrence of complete separation.[11] It is only fair to state that some of these cases had good functional results without operative interference.

Etiology.—Practically the mechanism of injury is of little importance. It is only surprising that the injury is as infrequent as it is. Its relatively infrequent occurrence in later life would seem to predicate its occurrence on a structural weakness due to the relative strength of the ligaments as opposed to that of the bone in childhood. A like structural dissimilarity between children and adults accounts for the predominance of supracondylar fractures to dislocations of the elbow in children, and *vice versa.*

Pathology.—The displacement of the epiphysis may be so slight as to be replaced by closed reduction or to require no reduction. It is the complete separation usually accompanied by rotation with which we are concerned. To quote Morris Smith, "The fracture line runs from the region of the external epicondyle downward and inward into the joint close to the junction of the capitellum and trochlea, coinciding in part of its extent with the epiphyseal line of the capitellum. The fixed point of its attachment is through the external lateral ligament to the radius below. The fractured surface in the typical case is turned outward so that it is subcutaneous, while the articular surface of the capitellum is directed toward the fractured surface of the shaft."[8] Wilson accounts for the displacement on the pull of the extensor muscles. Such displacement can be reduced only by open operation.[12] Pure epiphyseal separation is a great rarity.[2]

Cubitus varus ensued in 11 of 42 cases of Treves and cubitus valgus in six of the 42.[11] Kocher believed the latter more frequent than varus,[4] and some other writers found them of equal frequency. Treves considers such deformities of little more than esthetic importance. We are convinced that the valgus deformity when marked results in serious functional disturbances, such as we have seen in our case of excision. Further evidence of this is clearly shown by Miller.[6]

Treves attributes valgus deformity to fibrous union and the gradual ascent of the capitellum.[11] In our case there can be no question that the result is due to failure of growth and we believe with Stimson[9] and Wilson[12] that this is the true explanation of all late cubitus valgus deformities following fracture of the external condyle. The mechanical factors favor displacement of the fragment downward and outward as is seen in early cases, and, the upper limb not being subject to weight bearing, there is little tendency to late upward displacement of the loose fragment.

E. M. Miller, in a study of late ulnar nerve paralysis, found the primary cause of such paralysis in practically all cases to be due to fracture of the elbow in childhood (three to five years). From collected statistics he showed that 47 per cent of the late ulnar nerve paralyses were associated with fractures of the external condyle of the humerus; and 53 per cent of these late ulnar paralyses were associated with definite and marked cubitus valgus. This paralysis may begin as early as three years or as late as forty years after injury.[6]

Diagnosis.—If not obscured by swelling, the diagnosis is not difficult. The loose fragment can be felt on the outer side of the elbow, there is a fulness

at that point, and a marked lateral instability at the elbow. Roentgen rays of both elbows in the same position should be made to determine the exact extent of fracture and position of the fragment in true anteroposterior and lateral directions. In those with little or no displacement the diagnosis may be uncertain until roentgen rays show callus formation.

Treatment.—Stone,[10] Stimson,[9] Morris Smith,[8] and Cotton[3] advocate replacement in the early cases and excision in the late cases of six weeks and over. Broca[2] advises no immediate operative treatment for six months after injury, and then, only if there are definite indications such as impairment of

FIG. 1.—(Case II.) Roentgen ray January 27, 1928. Left elbow six months after injury. Separation of left external condyle. Preoperative anteroposterior view.

FIG. 2.—(Case II.) Roentgen ray February 13, 1930. Left elbow two years after operation (excision). Note beginning overriding of head of radius and lateral displacement of ulna with valgus deformity.

function by malunion or callus, pressure on the skin or compounding from the fragment, or beginning injury to the radial, median, or ulnar nerves. In such cases he favors excision, as he considers valgus deformity as a very remote occurrence. Treves is even more conservative than Broca. Kocher[4] and more recently Lee and Summey[5] advocate excision as the method of choice. There is no doubt that excision of the displaced epiphysis has resulted in good results in many cases, but if excision is resorted to indiscriminately some frightful deformities will occur. As excision has no advantage

over replacement in any case in children, we think it should be discouraged, even in the late cases.

Ideally replacement will result in union, continued growth of the epiphysis and no immediate or late deformity or disability. While replacement becomes increasingly difficult, Wilson reports a reduction with a good result in a case four years after injury which was maintained by bone graft and steel screws. He does not indicate whether the epiphysis continued to grow, which would appear unlikely.

In excision of the epiphysis the results are conditioned by two factors. These are the viable epiphyseal cartilage which remains, and the age of the patient; or, in other words, the potentiality for growth which remains. In the younger age groups with the highest fracture line results of excision will be worst. Few experiences are more disheartening than to watch what appears to be a good result become worse and worse as the years go by. As the other epiphyses continue to grow the concavity due to loss of the capitellum increases, the head of the radius lacking its normal support rises, causing an increase in the carrying angle, and slipping of the ulna outward. This results in a weak elbow with lateral instability, especially, and possibly, late ulnar nerve injury and arthritic changes. Excision, if ever justified, should be done only with these possibilities in mind and in children near the end of growth. Even if the replaced epiphysis fails to grow after injury, the deformity will be less than if excised, and we believe should always be attempted. Excision can be practiced at any time, but no new epiphysis with the power of growth can be substituted once it is removed.

FIG. 3.—(Case II.) September, 1934. Showing degree of deformity seven years after excision of external condyle.

Assuming, as is usually the case, that the loose fragment is outside the joint, the conservative treatment adopted by Broca and Treves should give equally as good results as excision. In fact, if fibrous union takes place, there may be less instability than where the epiphysis has been removed. The possibility of late valgus deformity due to failure of growth of the capitellar epiphysis is present as it is after excision.

Open reduction should be resorted to in all cases in which closed reduction has failed. This should be done as soon after the injury as possible. If

swelling is marked, the elbow may be elevated until it has largely subsided. Immediate open reduction is not difficult, and interrupted chromic sutures through the soft parts are sufficient to maintain the reduction. The forearm should be placed in acute flexion and maintained in that position for two weeks, or until firm union has occurred. Active flexion and gradually increasing extension are begun at that time and continued until complete function has returned. The preservation of complete active flexion will be assisted by

FIG. 4.—(Case III.) Roentgen ray July 18, 1929. Preoperative, anteroposterior, left elbow, with forearm in acute flexion.

FIG. 5.—(Case III.) Roentgen ray August 30, 1934. Five years after open reduction of left external condyle. The suture line is closed except for a small portion medial to the fracture site. The valgus deformity is slight as compared to Case II.

close observation, if the patient will coöperate in active exercises. After solid bony union has occurred, extension may be assisted by weight bearing. Passive motion is usually inadvisable in children; if forced it may cause displacement and will often discourage the child from coöperating in active motion. When coöperation cannot be obtained, skillful neglect will give better results than forced or coercive measures. If left to their own devices such children may be depended on to institute active motion of their own initiative.

Prognosis.—That an immediate good result may mislead the surgeon is well shown by the writer's experience with the Case II mentioned in the introduction. The patient was shown and accepted two years after injury (one and one-half years after operation) at the surgical section of the New York Academy of Medicine as a good result (Fig. 2). It is now seven years since injury and the deformity as shown in the illustration (Fig. 3) could mislead no one into accepting it as satisfactory. Nor can any surgical intervention now guarantee a good result. As a result of the injury or the long duration of the displacement before surgical intervention, further growth of the epiphysis might have been impaired. In such cases valgus deformity may result due to failure of growth. Even in these cases the deformity will be much less after replacement than following excision, except that when intervention is unduly delayed failure of growth is rare.

FIG. 6.—(Case III.) September, 1934. Showing degree of valgus deformity, after open reduction of external condyle.

CASE REPORTS

CASE I.—Male, two years, three months old. Admitted St. Mary's Hospital for Children, November 12, 1926. *History.*—Four weeks ago fell off chair on left elbow. Treated by family physician. *Physical Examination.*—Marked disability of left elbow. Flexion 80°. Extension 60°. *Diagnosis.*—Fracture external condyle of humerus, left. *Operation.*—November 16 (Dr. E. D. Truesdell). Ether anesthesia. Open reduction. Annular ligament of radius had to be divided to permit reduction. Joint and ligament resutured. Circular plaster in acute flexion. November 28, case removed. Wound clean. Starch bandage. December 3, starch bandage removed. Sling with forearm at 90°. December 31, discharged. Function complete.

CASE II.—Male, four years old. Admitted St. Mary's Hospital for Children, January 26, 1928. *History.*—Patient fell on floor injuring left elbow, July 7, 1927; treated at another hospital. *Physical Examination.*—Moderate atrophy of muscles of left arm and forearm. Function complete. Movable bony fragment lateral to elbow joint. Marked instability of elbow laterally. *Diagnosis.*—Old fracture external condyle of humerus, left (Figs. 1 and 2). *Operation.*—January 27, 1928 (Dr. J. H. Heyl). Ether anesthesia. Excision of displaced external condyle. Forearm in acute flexion. Starch bandage. February 5, wound clean. Stitches removed. February 6, baking and massage and active motion begun. February 9, discharged to out-patient department. Patient has been seen at six-month intervals since discharge from out-patient department. Condition in September, 1934, shown by photograph (Fig. 3). Function complete. Marked

and increasing cubitus valgus deformity left forearm. Beginning ulnar neuritis. Atrophy of muscles of left arm and forearm. Transplantation of ulnar nerve recommended.

CASE III.—Male, five and one-half years old. Admitted St. Mary's Hospital for Children, July 22, 1929. *History.*—Fell on point of left elbow two weeks ago. Laceration of skin and swelling and disability of left elbow. *Physical Examination.*—Swelling and ecchymosis over lateral aspect left elbow. Healed laceration. *Diagnosis.*—Fracture of external condyle of humerus, left (Fig. 4). *Operation.*—July 27, 1929 (Dr. C. E. Farr). Ether anesthesia. Open reduction. Forearm in acute flexion. Maintained with circular plaster case. October 3, wound clean. Sutures removed. Plaster replaced. October 4, discharged to out-patient department. October 8, plaster removed. Sling. Active flexion begun. *Follow-up.*—August 27, 1934. No complaints. Func-

FIG. 7.—(Case V.) Roentgen ray July 28, 1932. Preoperative. Right elbow.

FIG. 8.—(Case V.) Roentgen ray March 20, 1933. Eight months after open reduction of external condyle.

tion of elbow practically complete. Extension 180°, but as right forearm can be hyperextended, it might be considered as limited to something less than 5°. There is a moderate cubitus valgus. Epiphysis has failed to grow. In spite of failure of growth the deformity is much less than in Case II and there is no instability of elbow (Figs. 5 and 6).

CASE IV.—Male, five years old. Admitted St. Mary's Hospital for Children, August 20, 1929. *History.*—Four weeks ago while playing on an ice wagon fell four feet prone on palms of hands. Right elbow became swollen and painful. Disability of elbow. *Physical Examination.*—Crepitus, tenderness and swelling over right external condyle. Movements of elbow limited by pain. Iodine burn. *Diagnosis.*—Fracture external condyle of humerus right. *Operation.*—August 30 (Dr. J. H. Heyl). Ether anesthesia. Open reduction. Elbow in acute flexion. Maintained with adhesive plaster and Velpeau bandage. Discharged, September 5, to out-patient department. Wound

clean. *Follow-up.*—August 27, 1934. No complaints. No deformity. Function complete. Patient is right-handed and uses right arm in preference to left.

Case V.—Female, five years old. Admitted St. Mary's Hospital for Children, July 26, 1932. *History.*—Fell off step on right elbow. *Physical Examination.*—Moderate swelling about right elbow on lateral side. Lateral epicondyle is displaced upwards. Crepitus. Movement complete and moderately painful. *Diagnosis.*—Fracture external condyle of humerus, right (Fig. 7). *Operation.*—July 29 (Dr. J. H. Heyl). Ether anesthesia. Open reduction. Articular surface of lateral condyle facing forward, with complete lateral displacement. With forearm adducted and extended the fragment was replaced. Anterior and posterior molded splints with elbow in complete extension. August 10, sutures removed and arm in sling. Wound clean. August 25, marked limitation of flexion. August 26, forearm placed in acute flexion under general anesthetic. September 8, in spite of baking and massage, very little motion on discharge. No cooperation. *Follow-up.*—September, 1934. No complaints. No deformity. Function complete (Figs. 8 and 9).

Fig. 9.—(Case V.) September, 1934. Showing absence of deformity after open reduction of external condyle.

Discussion.—The ages of these cases varied from two years and three months to five and a half years. From the experience in Case II there can be little doubt that if excision had been practiced the results would have closely simulated the result in that case. In Case I the result would have been even worse, although no follow-up has been possible in that instance. In Case III only has the epiphysis failed to grow following reduction. Comparison of that case with Case II is the best argument that can be made for late reduction, because, in spite of growth failure, it has resulted in less deformity and a far more useful arm. We attribute failure of growth in that instance to the fact that the fracture line corresponded more closely with the epiphyseal line than in the other cases. Obviously in older children the results of excision would be better. We believe non-operative treatment gives as good or better results than excision.

I wish to express my appreciation to Dr. E. D. Truesdell and Dr. C. E. Farr for the privilege of reporting these cases.

REFERENCES

[1] Ashurst, A. P. C.: Anatomical and Surgical Study of Fractures of the Lower End of the Humerus. (S. D. Gross Prize Essay, 1910.) Philadelphia, Lea Bros., 1910.

[2] Broca: Decollements Epiphysaires et Fractures de la Region Condylienne Externe. Jour. des Practiciens, No. 28, vol. 97, p. 117, February 14, 1914.

[3] Cotton, F. J.: Elbow Fractures in Children. ANNALS OF SURGERY, vol. 35, pp. 75, 242, 365, 1902. *Idem:* Dislocations and Joint Fractures, 2nd Edit. Philadelphia, p. 319, W. B. Saunders Company, 1924. *Idem:* Fracture of Capitellum. Boston Med. and Surg. Jour., vol. 149, p. 734, 1903.

[4] Kocher, Emil Theodore: Breitrage zur Kentniss einiger praktischer Wichtiger Fracturformen, Basel. Salhmann, 1896.

[5] Lee, W. E., and Summey, T. J.: Fracture of the Capitellum of the Humerus. ANNALS OF SURGERY, p. 497, March, 1934.

[6] Miller, E. M.: Late Ulnar Nerve Paralysis. Surg., Gynec., and Obst., vol. 38, p. 37, 1924.

[7] Scudder, C. L.: Treatment of Fractures. 10th Edit. Philadelphia, W. B. Saunders Company, 1920.

[8] Smith, M. K.: Fractures of the External Condyle of the Humerus with Rotation. ANNALS OF SURGERY, vol. 86, No. 2, p. 304, August, 1927.

[9] Stimson, L. A.: Fractures and Dislocations. 8th Edit., p. 287, New York and Philadelphia, Lea and Febiger, 1917.

[10] Stone, J. S.: Fractures of the Elbow in Children. Jour. Orth. Surg., vol. 3, p. 395, 1921.

[11] Treves, A.: Resultats Eloignés et Traitément des Fractures de l'extrémité inférieure de Humerus chez l'enfant. Arch. de Médicine des Enfants, vol. 15, p. 721, October, 1912.

[12] Wilson, P. D.: Fractures and Dislocations in the Region of the Elbow. Surg. Gynec., and Obst., p. 335, February 15, 1933.

AVULSION OF EPIPHYSIS OF ILIAC CREST

By Samuel Kleinberg, M.D.
of New York, N. Y.

Epiphyseal fractures at the upper extremity of the femur are seen frequently; similar fractures at the lower end of the femur, tibia and radius are encountered, even in large centers for traumatic lesions, only occasionally. But an epiphyseal fracture of a flat bone, such as the ilium, is exceedingly rare. The case here detailed is the only one of its kind that has been admitted in ten years to a large general hospital with an ambulance service which brings a great number and variety of fractures, all of which are treated by the orthopedic division under my supervision.

The literature has only a meager reference to epiphyseal fractures of the iliac crest, due, probably, to the fact that not only is this lesion rare, but also because few surgeons see more than a single instance. Hence there is little incentive for intensive interest, particularly since the functional result is satisfactory with any form of therapy that includes freedom from weight bearing.

Hamilton in his book on "Fractures and Dislocations" is the only writer who gives the impression that fractures of the iliac crest are not uncommon. He reports a personal experience with six cases, and saw the pathologic specimens of three others in Doctor Neill's museum. All of his own cases were adults. In five of these the cause of the injury was a direct blow on the pelvis, as in a fall from a height. The sixth case was that of a man, seventy years old, who, when he arose from his seat in a moving railroad car, felt "something wrong" in his right hip, and was unable to walk. A fracture involving three inches of the ilium including the anterior superior spine was found. This was evidently caused by muscular violence. The cases reported by Kahnt, Karfiol and Kuhnast, who include abstracts of eight patients besides their own, each from the experience of a different surgeon, were all in adolescents. In all of these the lesion was produced by a muscular violence. My own patient belongs in this latter group in which the epiphysis of the iliac crest is still distinct and not fused to the body of the ilium.

Pathologic Anatomy.—The diagnosis in all but my own case was based on the history and clinical findings alone or in combination with an X-ray film of the pelvis. Some of the authors have spoken of the lesion under consideration as a tear fracture, "abrissfractur," of the anterior superior iliac spine. Kahnt entitles his report as an "epiphysenabriss," that is, a tear or avulsion of the epiphysis of the anterior superior iliac spine, intending, presumably, to include in this term a fracture of the epiphysis of the iliac crest. In my case it was distinctly more than the anterior superior iliac spine, as

at least three inches of the iliac crest were involved, thus confirming Kahnt's impression that the lesion was actually a tear fracture of the epiphysis of the iliac crest. It is extremely likely that we are dealing with and ought to distinguish two distinct lesions: (1) a true fracture of the anterior superior iliac spine, occurring in adults and resulting from a direct external force, as described by Hamilton, and (2) an epiphyseal tear fracture or avulsion of the iliac crest, found in adolescents and due to a muscular or indirect violence.

The ages of the patients range from three to seventy years. The epiphyseal avulsions have been found in individuals between fourteen and twenty years old.

The diagnosis is not difficult to make. The exact extent of the lesion may be doubtful from the clinical findings alone. The onset in all cases has been sudden, accompanied by sharp pain referred to the side of the hip, and followed by severe, sometimes total, disability. In most cases the patient felt a "crackle" at the hip at the time of the accident, indicating a break of the bone or a tear of the epiphysis. The affected hip is flexed and abducted. There is a swelling on the side of the hip over the ilium, tenderness to pressure, and a palpable bony mass which is abnormally movable and is usually displaced downward and backward away from the normal position of the anterior superior spine of the ilium. The X-ray film, which in all the reported cases has been an antero-posterior view, shows a small oval bony shadow below and behind the anterior-superior spine. In my case I took, in addition, oblique and lateral views, but these did not contribute anything toward accuracy in the differential diagnosis.

The treatment of the cases which I reviewed in the literature was conservative. Rest in bed alone or in conjunction with some form of pelvic support yielded good results.

CASE.—My patient, a boy fifteen years of age, was admitted to the orthopedic service at the United Israel Zion Hospital (Case No. 53644) in Brooklyn March 4, 1933. Three days previously, while running, he felt something "crackle" in his right hip. He was immediately almost completely disabled and had to be helped home. Thereafter movement at the hip was usually impossible. At times the hip would "snap" into a position in which the boy could stand, but he could not walk.

I found the boy in bed with his right lower limb flexed and abducted at the hip. He pointed to the region of the right anterior superior iliac spine as the site of all his pain, which was apparently considerable. There was a moderate swelling over the lateral aspect of the hip and an absence of the usual prominence of the anterior iliac spine. Instead of the latter there was a rough sensitive area. About two inches below the iliac crest a bony mass was palpable; this was tender to pressure. An X-ray film of the pelvis (Fig. 1) showed a rough, concave area instead of a smooth convex surface in the region of the iliac crest (a). Some little distance below it an oval shadow (b), as of bone, was visible. The obvious conclusion was that the lad had a fracture of the iliac crest with marked downward displacement of the fractured fragment. I decided upon an operative replacement of the displaced bone as the best means of establishing normal position of the iliac fragment, and perfect function.

Operation, March 7, 1933.—An anterior Smith-Peterson incision was used. At the iliac crest a large dark red blood clot, under which was exposed a roughened hemorrhagic bony surface, was found. A shell of bone and cartilage, about three inches long,

and three-quarters of an inch wide, rough on one surface and smooth on the other, with muscles attached to one border, evidently the iliac crest, was discovered displaced downward several inches below the superior border of the ilium. This fragment was cleared of blood clot and replaced on the superior border of the ilium, over which it fitted perfectly, and was secured there by interrupted chromic catgut sutures. The wound was sewn in layers. A short plaster-of-Paris spica was applied with the hip in a flexed attitude.

The spica was left on for about three weeks, until the wound, except for some superficial granulations, was healed. At this time the boy had excellent control of the limb, being able to lift it from the bed and to swing it sideways without effort or pain. A flannel spica bandage was applied, not because of any actual need for support, but rather to remind the boy to be cautious in walking. The end result is a complete cure.

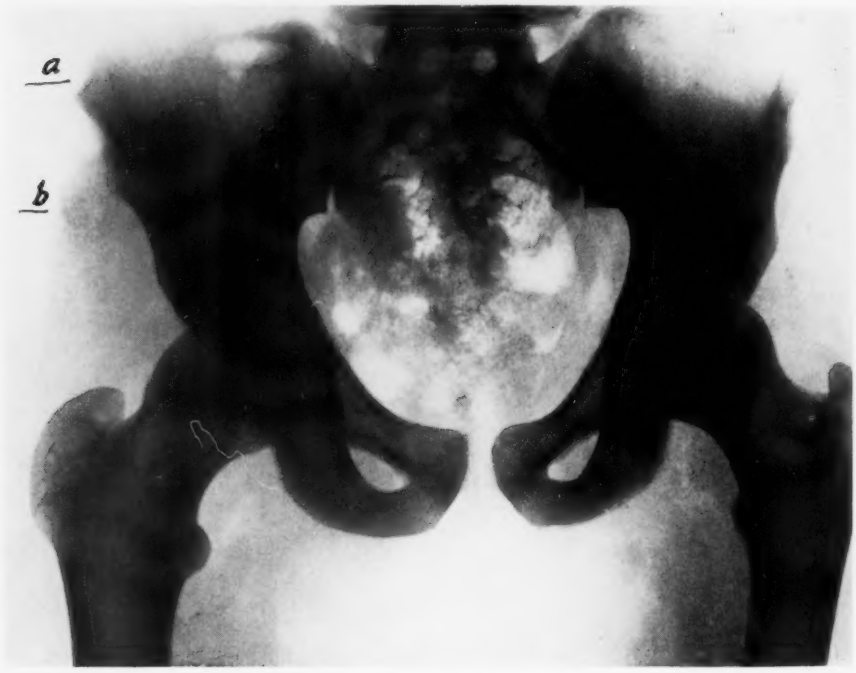


FIG. 1.—X-ray of pelvis showing evulsion of right anterior superior spine of ilium.

The fracture was manifestly the result of a sudden muscular violence. The history does not permit any conclusion as to whether the movement causing the fracture was a contraction of the tensor fascia femoris during violent flexion of the hip, or an unusually severe hyperextension of the trunk. As the fragment of bone corresponded to the origin of the tensor fascia femoris, it would seem plausible to believe that a violent contraction of this muscle, either when the trunk and pelvis were in a fixed position or when, perhaps, the foot on the affected side was caught so that it could not readily be displaced, pulled off that part of the epiphysis of the iliac crest to which it was attached.

The question as to the advisability of replacing the displaced fragment was raised by my house staff, since in paralytic contractures at the hip, doing

the Campbell operation, one deliberately lowers the attachment of the tensor fascia femoris including a part of the iliac crest. My answer to this argument was that, in infantile paralysis, with a flexion contraction at the hip, we are confronted by a deformity and a serious functional weakness resulting from the malposition, hence the operative displacement and lowering of the attachment of the tensor fascia femoris is a matter of necessity and not of choice. Whereas, in the present instance we were dealing with a traumatic lesion which was susceptible of a complete anatomic and functional cure through a very simple operation.

This case seems worthy of record because (1) it presents a very rare type of epiphyseal injury; (2) it was possible at operation to determine the exact extent and nature of the lesion, and (3) by operative replacement and fixation of the epiphyseal fragment, an opportunity was provided for a perfect recovery.

REFERENCES

[1] Hamilton, F. H.: A Treatise on Fractures and Dislocations, pp. 404–407, Lea's Sons & Co., Philadelphia, 1884.

[2] Kahnt, E.: Epiphysenabriss der Spina Iliaca Anterior Superior als Sportverletzung bein Schnellanf. Zentralbl. f. Chir., No. 33, p. 2057, 1930.

[3] Karfiol, G.: Uber die isolierte Abrissfraktur der Spina Iliaca Anterior Superior. Zentralbl. f. Chir., No. 13, p. 789, 1930.

[4] Kuhnast, W.: Die Abrissfrakturen der Spina Iliaca Anterior Superior. Arch. Orthop. Chir., vol. 23, p. 460, 1925.

AN AMBULATORY METHOD OF TREATING FRACTURES OF THE PATELLA

By Roger Anderson, M.D.

of Seattle, Wash.

From the Orthopedic Service, Harborview Hospital, Seattle, Wash.

Many physiological and economic advantages follow this new method of treating fractures of the patella, which permits immediate ambulation. The fact of walking is most pertinent to injuries of this structure, because the musculature to the knee is more susceptible to atrophy than that of other joints.

This method is founded upon two principles, namely: (*a*) Reduction by the application of skeletal traction to the upper patellar fragment, and (*b*) immobilization through the agency of a case in which are incorporated both this superior transfixion and a distal anchoring pin, passed through the upper end of the tibia.

Dual skeletal transfixion has been previously used in regulating patellar fractures. Among other workers we note that Malgaigne[1] applied a special clamp equipped with hooks; Moorhead[2] transfixed each fragment with a needle; Klapp[3] also made similar insertions but with wires attached to pulleys and weights. We have been unable to find any reference, however, to a method which permitted ambulation.

The usual desideratum in fractures of the extremities is to apply traction to the distal fragment to overcome shortening. With patellar traumata the problem is reversed as traction is applied to the upper fragment to correct separation. Since our experience in fractures of the long bones has demonstrated that skeletal traction fixed in plaster is productive of the best results, these principles were applied to the patella. In our early cases the upper patellar fragment only was transfixed by the pin and incorporated in plaster of Paris, since the rôle of the countertraction anchor at that time was accomplished by embedding the sole of the foot in the same case. By this means retraction of the upper fragment was inhibited. Subsequent changes in technic, as double skeletal transfixion, have been made without altering our original principles.

When the following anatomical facts are reviewed, the practicality and safety of this new method will be obvious; a logical procedure since reduction is always dependent on control of the musculature. With the exception of the under surface of the patella, which is cartilage covered, this sesamoid bone lies completely enveloped by the expanded tendon of the quadriceps muscle, which divides into three major parts as it extends downward (Fig. 1). One division attaches directly into the superior surface of the patella; a second portion passing to each side forms the anterior fibrous capsule for

the knee-joint; the third portion, anterior to the knee-cap, extends distally as the patellar ligament, and inserts into the tibial tuberosity.

The patella is without periosteum, but the aponeurosis to a limited extent serves that purpose. When fracture occurs, the patella is separated through displacement of the superior fragment alone, in direct ratio to the extent of the rupture of the anterior capsular structures. On the other hand, the distal fragment remains in its normal position, since the patellar ligament is nonelastic.

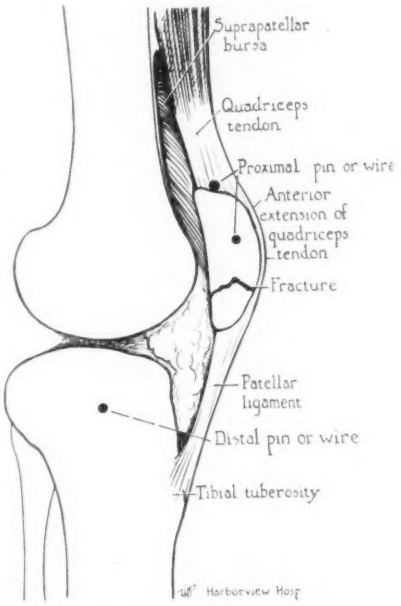


FIG. 1.—The knee-joint showing affiliations between the extensions of the quadriceps tendon and the patella. The part anterior to the patella extends distally as the nonelastic patellar ligament to insert in the tibia. Note the relationship of the suprapatellar bursa to the superior transfixion, also the position of the patella anterior to the femoral condyles, when the knee is in full extension.

REDUCTION.—Fractured patellæ are reduced immediately after trauma, subsequent to scrupulous surgical preparation of the extremity from mid-thigh to mid-leg. The anæsthetic may be 2 per cent. novocaine, spinal or general.

Experience has taught us that it is preferable to use wire to transfix the upper patellar fragment and a pin for the tibia (Fig. 6). A slender Steinmann pin of special flexible stainless steel, 4/32 of an inch in diameter, transfixes the tibia at its flared-out upper end, about a finger's breadth distal to the knee-joint; while for the superior transfixion a stainless steel Kirschner wire is used. We have become advocates for wire transfixion of the patella since devising a simple means of maintaining sustained tautness in the wire. A small stainless steel Tautnor, one pound in weight, has been designed to keep the wire tight during convalescence, its size and weight adding little, if any, inconvenience to the ambulatory patient (Fig. 2). This Tautnor is equipped with side studs for speedy attachment to the automatic splint, which provides mechanical adjustment and rotation upon the normal anatomical axis.

Steps in Routine Technic.—(1) A transverse incision is made to expose the fracture and remove the interfragmentary blood-clots.

(2) The proximal wire or pin is inserted through the proximal fragment or through the quadriceps tendon, the left index finger in the suprapatellar bursa acting as a guide.

(3) The distal pin or wire transfixes the upper end of the tibia. Dry dressings are now spiked over ends of both pins or wires. If wire has been used sterile Tautnors are attached and tightened.

(4) Reduction is accomplished by drawing and holding the Tautnors or

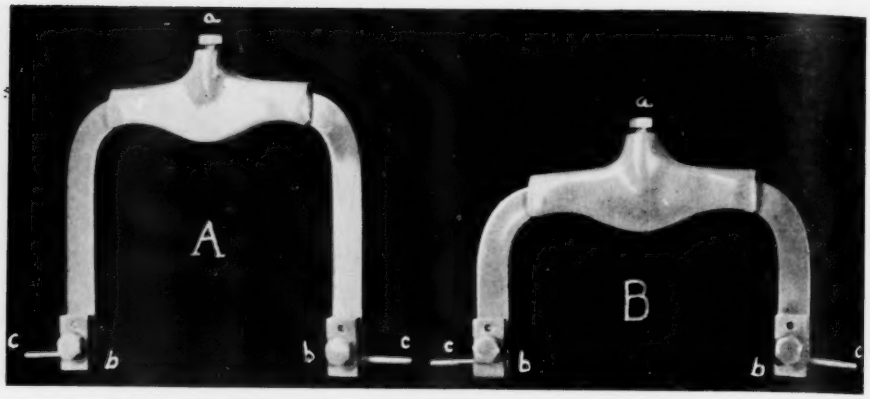


FIG. 2.—These wire Tautnors, which differ in size only, are operated under the same simple instructions. After unscrewing the centre bolt "*a*" and while the sides of the Tautnors are pressed inward, the Kirschner wire is clamped by tightening nuts "*b*." Whereupon the centre bolt is screwed in with the fingers, the wire positively tightened by one complete turn with the wrench. The side lugs "*c*" present a ready means for fastening the Tautnors into the horseshoes of the automatic splint. It is the position of the lugs which assures maintenance of rotation on the normal anatomical axis.

(A) (B)

FIG. 3.—Mr. M. M. Lateral rœntgenograms: (A) before reduction; and (B) eight weeks after reduction.

pins together with a bandage, after which the aponeurosis is sutured lightly with chromic No. 0 catgut, while the skin is closed in the usual manner.

(5) A padded or unpadded plaster bandage is applied from groin to ankle incorporating Tautnors or pins, and reduction is rœntgenologically checked. It is frequently advisable to split the case.

Technical Assistance.—To aid reduction and to prevent displacement while suturing or applying the plaster, the use of the automatic splint equipped with

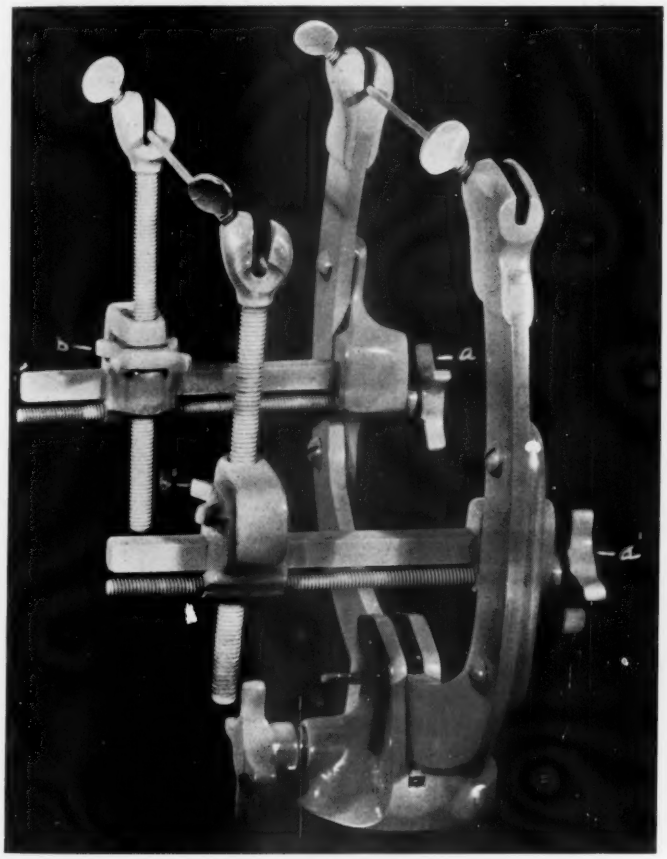


FIG. 4.—A detailed view of the side-arm extensions. Function demonstrated by Fig. 5. This adjuvant to the automatic splint is quickly connected to the superior surface of the upper horseshoe. The fragments can then be readily approximated with mechanical certainty, since every requisite for traction, elevation and rotation is available. By simultaneously turning finger nuts "a," "a'" in the same direction, we obtain contraction or distraction; whereas sidewise rotation is obtained by turning both nuts simultaneously in the opposite direction, or a nut at a time. A higher or lower elevation is possible through the simultaneous turning of nuts "b," "b'" in the same direction; whereas a turn in the opposite direction, singly or simultaneously, results in rotation in the anteroposterior plane.

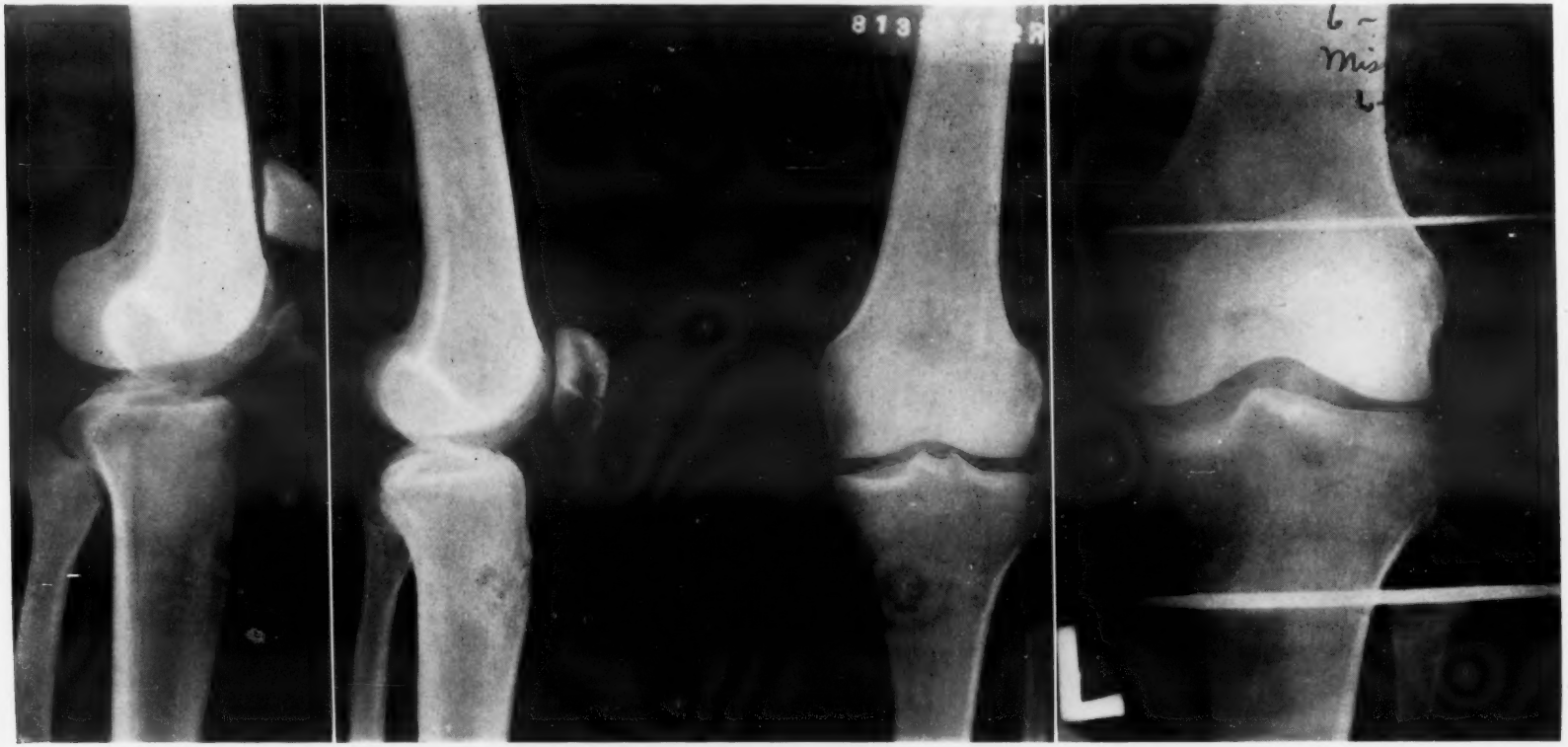
the side-arm attachments is suggested (Figs. 4 and 5). Time permitting, the splint should be sterilized in the autoclave as all adjustments can then be made with sterile gloves. However, an unsterilized apparatus may be used, provided that certain precautions are observed. Incision and transfixions

are routinely performed as outlined, after which a sterile lap sheet with a small opening about five inches in length is clipped tightly around the incision. The leg is then placed in the apparatus, which is under the sheet, while the nonsterile assistant effects reduction.

Although the stand is demonstrated with the splint in Fig. 5, the apparatus works equally as well without the stand, provided the base of the footplate is attached to the under surface of the distal end of the splint, by which means the long axis of the splint is made to conform to that of the inclined plane of the thigh.

FIG. 5.—Demonstrating the practical application of the side-arm extensions as detailed in Fig. 4. Double pin transfixion is employed here, but wire with the Tautnors may be used equally well. The splint can be sterilized so that either closed or open technic may be used.

NON-OPERATIVE REDUCTION.—Transverse fractures with separation may now be reduced without resorting to open operation if cognizance is taken of the usual clinical behavior of the ruptured aponeurosis. This tendinous expansion over the anterior aspect of the cap is so firmly attached to the patella that the fibrous rupture usually coincides with the osseous fracture, separating much in the same manner as wall paper when the underlying plaster cracks. Hence, in this type of fracture, there is less danger of loose aponeurotic edges dropping between the fractured parts; whereas, with comminuted fractures, the tendinous expansion may be extensively lacerated with smaller fragments of bone torn loose and so rotated that the fimbriated ends become interposed between the bony fragments. Therefore, the comminuted fractures usually



(A) (B) (C)

FIG. 6.—Miss E. R., compound transverse fracture of the left patella. The wound had been débrided and closed elsewhere the day previous, but the fracture was not reduced owing to multiple injuries which included a fracture dislocation of the hip. On recovery from shock we inserted a Kirschner wire blindly through the patella and a pin through the tibia, as illustrated in (C). The separation before reduction (A) is shown fully corrected in the lateral and anteroposterior rœntgenograms in (B), taken about eleven weeks after trauma. Soon afterwards the patient was allowed to return to active nursing duties.

demand open reduction for the removal of this material, which is prevented from again dropping between the fragments by suturing the aponeurosis.

Closed Reduction.—With the exception of the incision, technical details are similar to the routine operative procedure, but greater care must be exercised when the Kirschner wire is put through the upper fragment without the advantage of guiding the transfixion with the finger in the suprapatellar bursa. If this fragment is so mobile as to render transfixion difficult, it may be grasped and held with a large towel clamp, or uterine vulsellum, or one or two Steinmann pins may be temporarily spiked at right angles to the anterior surface of the patella.

Compound Fractures.—Fresh nonextensive compound fractures are débrided, after which transfixion, closure, reduction and plaster encasement are performed either by the open or the closed technic. But extensive comminuted fractures are débrided and the loose, practically unattached bits of bone are removed prior to transfixion. The wound may be sutured; it may be packed with vaseline gauze or even left open, as clinically indicated. In any event it may be advisable that the leg remain in the automatic splint, thus having both the fracture and the knee-joint fully exposed for lavage, drainage, or subsequent surgery. To keep the exposed leg from sliding sidewise on the wires or pins, the space between the leg and the horseshoe is filled with buttons of felt or cork. When the leg is left in the apparatus, removal to surgery is made without fear of disturbing apposition.

Should suppuration be inevitable, the superior transfixion may be blindly put through the quadriceps tendon while the distal pin may be inserted through the lower end of the tibia. In such an instance, to prevent the leg from sagging at the knee, a sling is either passed under the knee and attached to the upper horseshoe, or a sandbag is placed under the knee.

Old Fractures with Separation.—The neglected or untreated case of several months' standing with resultant contracture of the muscle can now be reduced with the aid of the automatic splint, without resorting to plastic surgery on the quadriceps tendon. This difficult problem is approached by first resecting the fibrous union and freshening the bone ends, after which the upper fragment is pulled down as far as possible by means of a tenaculum. The wire or pin is next inserted for completion of traction by means of the splint. But should it be impossible to obtain approximation at time of operation, the wound may be closed and the fragments gradually brought into contact during the succeeding days. The mechanical positiveness of the automatic apparatus is of material assistance in co-adaptating the fragments; furthermore, the leg may safely be left in the splint for as many days as required to effect reduction. This gradual muscle stretching is analogous to bone lengthening technic.

Multiple Fractures.—Fractures of the patella complicated by fractures of the tibia and fibula, the os calcis or fracture dislocation at the ankle may be simultaneously reduced with relative ease if the automatic splint is employed.[4, 5] Even if the associated trauma is a spiral fracture of the tibia,

ambulation with crutches is still possible. And contrary to so-called axioms of fracture therapy, all the other multiple fractures designated above become immediately ambulatory by incorporating a walking stirrup in the case.

AFTER-CARE.—Immediate ambulation, without the aid of crutches, is not only permitted but insisted upon as soon as there is recovery from the anæsthetic. Patients are then completely dressed in their customary manner. The inside seam of trousers may be opened and fastened over the case with safety pins or snaps, enabling those employed in office capacity to resume their duties. The daily exercise of walking is the greatest prophylaxis against muscle atrophy and other soft-tissue alterations.

FIG. 7.—Demonstrating proximal and distal wire transfixions with Tautnors, also fenestration of the case for removing sutures.

The plaster bandage may be safely fenestrated for removal of sutures. At the end of the third week, if desired, the case may be removed on the posterior side of the thigh and the knee for flexion at the joint. The pins and case are usually removed from the fourth to the sixth week. No attempt should be made to dress pin wounds during this period. Further immobilization may be obtained with a posterior molded plaster splint, to be followed by a knee bandage. After immobilization is discontinued it is gratifying to note how soon the usual physiotherapy results in excellent joint function.

X-rays should be taken at frequent intervals, distortion on the lateral view overcome by using a dental film, which is placed in between the wires or pins close to the patella. Any adjustments may be made as outlined below.

The case should be spread open on the first sign of circulatory dangers. Although a snug plaster bandage applied early limits effusion, in cases when pre-operative swelling was marked the casing may later become correspondingly loose. To correct this condition, a vertical section of sufficient size should be removed so that the casing can be tightened with muslin or plaster bandage. Pain on walking, which occasionally appears after the second or third week, is generally attributable to a loose case with side-play of the tibia on the distal pin. This demands reincorporation of the distal pin in a tighter case, applied after removing a portion of the old plaster from around the pin. Care must be taken that the same relative position of the pin be maintained until the plaster sets. It may also be advisable at

times to reincorporate the superior transfixion, either to make the plaster fit more snugly or to correct reduction.

SUMMARY

The chief advantage of this new method for all fractures of the patella is the ability of immediate ambulation, which results in many physiological and economical benefits. Furthermore, principles delineated provide a practical nonoperative approach to treatment of certain fractures of the patella.

REFERENCES

[1] Malgaigne, J. F.: Dennis System of Surgery, vol. I, p. 553. Lea Brothers and Company, Philadelphia, 1895.

[2] Moorhead, John J.: Traumatotherapy, p. 311. W. B. Saunders Company, Philadelphia, 1931.

[3] Klapp, R., and Block, W.: Die Knochenbruchbehandlung mit Drahtzugen, pp. 197–198. Urban and Schwarzenberg, Berlin, 1930.

[4] Anderson, Roger: An Automatic Method for Fractures of the Tibia and Fibula. Surg., Gynec., and Obstet., vol. 58, p. 639, March, 1934.

[5] *Idem:* Mechanical Reduction of Fractures of the Os Calcis and Dislocation of the Ankle. (In process of preparation.)

ANKLE BONE BLOCK FOR PARALYTIC DROP FOOT

END-RESULTS OF EIGHTY-FIVE CASES, 1925–1932

By Lewis Clark Wagner, M.D.

of New York, N. Y.

FROM THE HOSPITAL FOR RUPTURED AND CRIPPLED

This report is confined to a complete study of eighty-five cases covering a period of seven years, in which the modified bone block of Campbell has been used. It has yielded most gratifying results. None of the cases has been under eleven years of age, but the age which is considered best for the operation is beyond fourteen years, when the bones of the feet have attained their normal growth. The cases are of a definite foot drop, which are associated with an active calf-muscle group and at times a slight power in the tibialis posticus. The greater number show an etiology of anterior poliomyelitis, but there are many cases of spastic equinus due to hemiplegia of a congenital origin, lethargic encephalitis or fractures of the spine. The flaccid paralyses due to traumatic division of the common peroneal nerve are also included. Most of the cases were associated with a marked varus deformity of the foot which needed operation correction by wedge resection on the outer border of the foot. The operations were performed at the Hospital for the Ruptured and Crippled, the Neurological Institute and St. Mark's Hospital.

Fig. 1.—X-ray showing posterior bone block according to Campbell's technic. There has been a fracture of bone. The result is satisfactory so far as the drop was checked, but there is no motion in the ankle-joint. Case was operated upon again with technic of new type of bone block.

Reasons for Modification.—In a number of my earlier cases and following the Campbell technic, a stiff ankle resulted and the only motion was in the mid-tarsal regions. (Fig. 1.) At times a secondary varus deformity with adduction of the forefoot also was noted. These deformities make locomotion difficult and cause an awkward gait or heel walking, with secondary strain on the knee-joint. Fractures of the tip of the transplanted bone often occurred accompanied by no symptoms but often followed by increased motion in the ankle-joint and were due to breaking up of the anky-

losis. In some cases we were obliged to excise the redundant tip to secure motion in the ankle-joint and also to correct the secondary varus and adduction deformity of the forefoot by excision of a wedge including the calcaneo-cuboid articulation.

Mechanics.—Upon excision of the tip of the transplanted bone in the region of the posterior surface of the tibia, a satisfactory result was evident, and also increased range of motion. By this fact, it was revealed that very little impingement of transplanted bone was necessary to obtain the desired

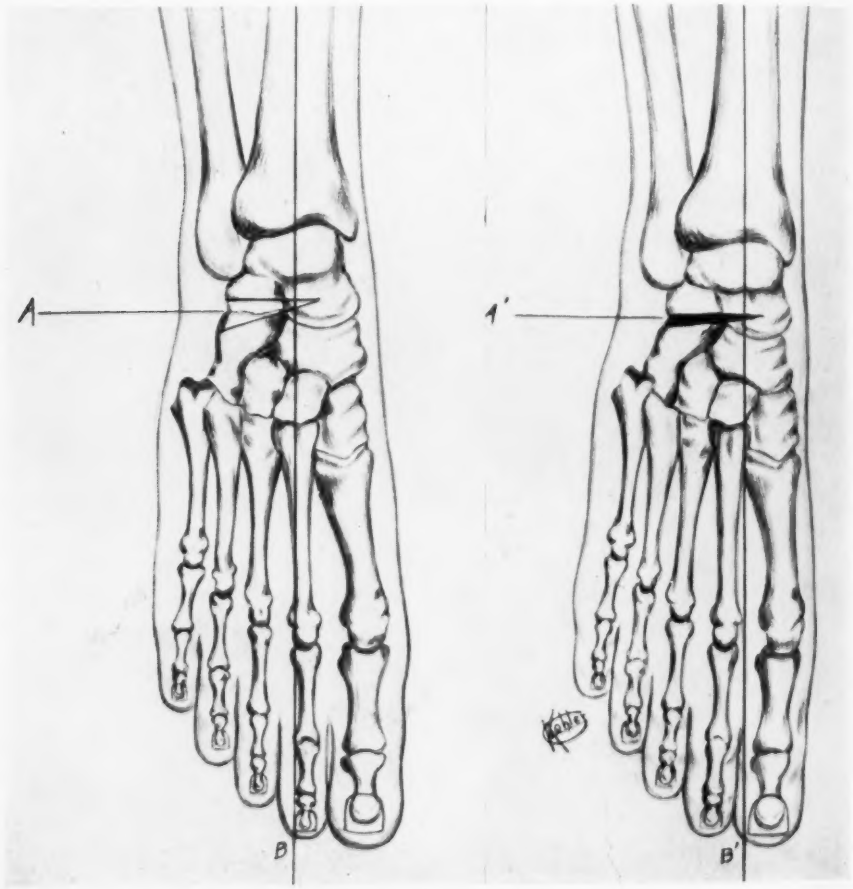


FIG. 2.—Excision of the calcaneo-cuboid articulation (A) and by abduction of forefoot (A') the line of weight-bearing is transferred from B to B'.

result in prevention of the drop foot. We have all noted how a small displaced osteochondral fracture in the knee-joint or elbow-joint may limit motion. By using the same principle and elongating the posterior surface of the astragalus, a normal joint can be secured and the drop foot satisfactorily prevented, with a considerable range of motion in the ankle-joint proper. By excision of the calcaneo-cuboid articulation and placing the forefoot in slight abduction and valgus, further deformity is completely prevented.

Technic.—The operation is performed with the use of a tourniquet. The first step in the operative technic is the excision of the calcaneo-cuboid articulation (Fig. 2-A) and the correction of the varus and placing of the forefoot in abduction (Fig. 2-A′). The posterior ankle-joint is then exposed through a small incision lateral to the Achilles ten-

FIG. 3.—First step of Campbell's operation is the removal of the posterior part of the astragalus as shown by line *C*.

don and the tendon is divided as in Campbell's original description. The deeper structures are reflected lateral from the mid-line and the ankle-joint proper is entered. The projecting portion of the astragalus is excised with a curved flat chisel (Fig. 3-C) and the subastragaloid joint is destroyed, taking a large wedge from the outer side of the

FIG. 4.—Second step in Campbell's operation is the obliteration of subastragaloid (posterior) joint (D).

articulation so that the posterior part of the foot can easily be placed in valgus. A large section of the os calcis measuring three by two by one centimetre (Fig. 5-E) is reflected, shaped and fitted under the posterior aspect of the tibia (Fig. 6-E′) with the denuded surface of the transplanted bone resting against the astragalus. The trans-

planted bone must fit accurately and touch the inferior surface of the tibia only when the foot is in 10° of plantar flexion. The transplanted bone should remain in place without fixation, if it is cut properly. The deeper tissues are then closed with interrupted

FIG. 5.—A large flap of bone (E) has been removed from the os calcis. The smooth surface is intact and the subastragaloid joint (D') obliterated.

sutures over the posterior articulation of the ankle-joint. The tendo achillis is repaired with elongation. A plaster-of-Paris dressing is applied with foot at right angles to the leg and in valgus and the forefoot in slight abduction. Walking is begun in plaster at

FIG. 6.—The reflected part of the os calcis (E) is placed under the posterior part of the tibia and approximates the posterior part of the astragalus (E'). This differs from the technic of Campbell, who describes his procedure thus: "Small particles are packed in a pyramidal manner extending one inch above and posterior to lower extremity of tibia." A new process is thus made which will impinge upon the inferior and posterior aspects of the tibia. (See Fig. 1.)

the end of one month and the plaster-of-Paris dressing is entirely removed at the end of the third month. The outer border of the shoe, heel and sole, is raised 1/8 inch to retain the valgus position of the foot and walking is allowed without support. The elevation

of the shoe is continued for one year, after which time any type of shoe is satisfactory, without alteration.

Three cases were re-operated upon and the posterior surface of the ankle-joint was explored. Each case was done for experimental reasons. Sufficient time had elapsed to secure a normal articulation and the history of two is given below as follows:

CASE I.—May M., aged fourteen. Hospital for Ruptured and Crippled, August 12, 1929. Patient had an attack of poliomyelitis when twelve years of age and was under the care of Dr. Reginald Sayre. Examination showed patient to be in good condition and walked with a limp on the right side. There was no paralysis of any muscle about the

FIG. 7.—Normal foot with weight-bearing line A. (See Fig. 2.) (A') Weight-bearing line with forefoot abducted following excision of the calcaneo-cuboid joint.

body except below the right knee. The foot was in an attitude of equinus. There was paralysis of the tibialis anticus and also of the peroneal group. There was 50 per cent. power in the gastrocnemius group. The tibialis posticus was active. There was normal range of motion in the toe muscles. Measurements of both legs are the same in length.

Diagnosis.—Old poliomyelitis; paralysis of the tibialis anticus; paralysis of the peroneal group; paralytic drop foot.

A typical bone block was done and the X-ray showed the result to be satisfactory. The plaster was removed at the end of three months and walking without support was started. She was started walking with the foot in slight valgus and 15° of motion in the ankle-joint. Patient was kept under observation and re-examination on August 26, 1931,

showed that the foot was blocked at a satisfactory angle, but a varus deformity had developed. This caused the patient to walk on the outer border of the foot. The deformity was most noticeable at the calcaneo-cuboid joint, and for this reason she was re-admitted to the hospital and the deformity corrected by the removal of a wedge from the calcaneo-cuboid joint.

At this time, for experimental reasons, an incision was made on the posterior surface of the foot in the region of the bone block. The skin was divided, the tendo achillis was pushed aside, and the posterior ankle-joint was explored. There were no loose bodies in the joint. The articulation was smooth. There was fluid in the joint. The region of the block seemed to be covered by a cartilaginous material. A small piece of joint surface was removed measuring about one-eighth inch by five-eighths inch, without disturbing the contour of the articulation. The wound was then closed in the usual manner.

She was re-examined again in November, 1932, and there was no recurrence of the deformity. The foot was in valgus and with about 15° of plantar flexion. There was no pain and walking was satisfactory.

Case II.—Anna E., aged twenty-six. Hospital for Ruptured and Crippled, May 7, 1930. Patient gives a history of having had an attack of infantile paralysis when she was a very little girl and was treated in the out-patient department of the hospital. At that time she was in good condition and walked with a marked limp on the left side, the foot in an attitude of equino-varus. There was a normal power in all the muscles of the body except the left leg below the knee. There was considerable atrophy of the leg. There was complete paralysis of the tibialis anticus and of the peroneal group. The flexor muscles of the toe were paralyzed. There was about 75 per cent. power in the gastrocnemius group. The extensors of the foot were not paralyzed. There was a half-inch difference in measurement of both legs in length.

Diagnosis.—Old poliomyelitis; equino-varus deformity; paralytic dropfoot. A typical bone block was done and convalescence was normal. The plaster was normal. Plaster was removed at the end of three months and patient allowed to walk. The foot at that time was at a right angle to the leg and in slight valgus. The patient could walk with ease and was examined from time to time.

One year later a varus deformity developed. The deformity was most noticeable at the calcaneo-cuboid articulation. She was re-admitted to the hospital on January 9, 1931, and a wedge was taken out of the outer border including the calcaneo-cuboid articulation and the varus was completely overcome. For experimental reasons, the posterior surface of the ankle-joint was explored with the original incision in order to inspect the region of the ankle-joint where the bone block was performed. After the division of the tissues, the joint was entered. The articulating surfaces were smooth. The transplanted bones from the os calcis articulated with the lower end of the tibia. There were no loose fragments in the joint. The corner of the articulation was removed, measuring one-half inch in width and one-quarter inch in thickness, without disturbing the contour of the articulation.

Patient was re-examined on December 10, 1932. At that time there was no recurrence of the varus deformity. The bone block was satisfactory and the patient walked almost without a limp.

Material for study was secured by excision of a part of the articulating surface of the bone block. The edge of the articulation was removed and contained the whole thickness of the projecting part of the transplanted segment of os calcis. At this time it was noted that the joint was bathed in synovial fluid. The transplanted segment of the os calcis was smooth and within the capsular ligaments of the ankle-joint. The edges were smooth and no loose bodies were noted. The articulating surface of the transplanted bone was continuous with the upper part of the astragalus and it was difficult to differentiate between the two smooth surfaces. The elongated surface of the astragalus was fused to the os calcis and was part of it. Histological sections (Fig. 10) were

F

G

H

FIG. 10.—Histological sections. (F)—Low power showing three layers bone, fibrocartilage and articular surface. (G)—Medium power showing bone layers well developed and normal structure. (H)—High power of articular surface showing development of synovial cells. (H') in many stages of activity.

composed of three surfaces: bone, fibrocartilage and articulating surface. The bone layers were well developed and contained a normal structure of bone. The cartilaginous layer was well developed and contained many cells. It was of a fibrocartilage type and of early development rather than adult articular cartilage. The articular surface under

FIG. 8.—X-ray (January, 1933) of foot four years following operation. (Case Ruth W., aged seventeen, when operation was performed.)

high power (Fig. 10 H H′) showed development of young and old synovial cells in many stages of activity. One is led to believe that the transplanted bone has taken on the function of the part played in the joint activity and likewise the characteristics one would expect to find in a normal weight-bearing joint. One is at a loss, however, to

FIG. 9.—X-ray (January, 1933) of foot seven years following operation. The smoothness of the articulation is demonstrated; there is no bone production. (Case Victor L., aged fifteen when operation was performed.)

state definitely whether the articular surface may not be an outgrowth from the upper part of the astragalus. From these findings, one can see that a new functioning joint with almost a normal histological picture is formed.

Röntgenology.—Dr. Raymond Lewis, röntgenologist of the Hospital for Ruptured and Crippled, has made the following comparison of the X-rays of the Campbell bone block and this new procedure as related to the anatomical

development of the transplanted bone and the arrangement of the articular surfaces of the ankle-joint with the mechanism of support:

The lateral views of the foot (Figs. 8 and 9) show that a smooth bony body with orderly bony trabeculæ is fused to a new artificially made posterior surface of the astragalus and to a denuded upper surface of the calcaneus in the region of its posterior articular facet and to the bone just behind. The fusion is shown to be solid. The upper surface of this new bony body is very smooth and lies immediately beneath the posterior margin of the lower tibial articular surface, with a space of about one-quarter inch separating this new bone and the tibia. This upper surface seems to be continuous with the upper astragalar articular surface. With a small amount of plantar flexion this smooth surface would apparently come in contact with the posterior margin of the lower tibial articular surface and prevent further plantar flexion. The films also show an obliteration of the posterior astragalo-calcaneal and calcaneo-cuboid articulations.

In comparing these films with a film illustrating the Campbell bone-block operation (Fig. 1) the present operation would seem to have several mechanical advantages. The present bone block is really a part of the astragalus and produces blocking by impingement of its upper extremity against the tibia. In the film illustrating the Campbell bone block, the bony body seems to consist of an exostosis projecting upward from the upper surface of the calcaneus into the soft tissues. It prevents plantar flexion by impingement of its anterior surface rather than its tip against the tibia in such a way as to produce a cross strain on this exostosis.

End-results.—The analytic classifications of the eighty-five cases done by the modified bone-block procedure were as follows:

Anterior poliomyelitis was proven the etiology in sixty cases of paralytic equinus, with four cases being due to traumatic division of the common peroneal nerve. The cases of spastic equinus were divided as to etiology; eleven spastic hemiplegia, congenital; seven the legacies of a fractured spine; and three due to the remains of lethargic encephalitis.

Varus deformities occurred in eight cases, and were necessary to be corrected by wedge resection of the calcaneo-cuboid joint. The occurrence of this deformity was explained by an active tibialis posticus muscle. Because of this fact the routine resection of the calcaneo-cuboid articulation is practiced and the varus deformity is not noted in my later cases.

The cases that show the most satisfactory walking gait are those in which the range of dorsiflexion is the greatest and produced by considerable elongation of the Achilles tendon.

The operations performed for spastic equinus in the hemiplegia have prevented the recurrence of the equinus with marked diminution of spastic tendencies. I am not prepared to explain the loss of spasticity.

One operation performed a year after plastic repair of the common peroneal nerve was found to have secured the return of function to the nerve, but the bone block was not removed as the patient was satisfied.

Of the total number there were three bilateral cases and the only death noted was in the series (case of bilateral spastic equinus due to the after-effects of lethargic encephalitis and death occurred immediately after operation).

In sixteen of the cases there was a slight difficulty in the healing of the

posterior incision but within one to three months they ended with satisfactory scars. There were no infections of the transplanted bones or joint surfaces.

Only one case required revision of the height of the transplanted segment of os in order to allow more plantar flexion.

Summary.—An operation procedure (histological anatomy and X-ray study) consisting of a modification of the classical posterior bone block of Campbell is presented. It consists of an excision of the calcaneo-cuboid articulation (to prevent adduction and varus deformity of forefoot); a posterior subastragaloid arthrodesis with a constructed anatomical elongation of the posterior aspect of the astragalus produced by a reflected segment of the os calcis, in order to articulate with the inferior posterior surface of the tibia. The degree of plantar flexion can be accurately controlled by the height of the reflected transplanted segment of the os calcis. The final result is a foot in the attitude of weakness (valgus) and blocked in plantar flexion at an angle of not more than 105′ which relieves the paralytic equinus, thus securing an extremity which is stable, painless and with 10′ to 15′ of motion in the ankle-joint proper, with which walking can be executed with grace and ease.

BIBLIOGRAPHY

[1] Campbell, W. C.: An Operation for the Correction of Drop Foot. Jour. Bone and Joint Surg., vol. 5, p. 815, October, 1923.

[2] Campbell, W. C.: End-results of Operation for Correction of Drop Foot. Jour Am. Med. Assn., vol. 85, p. 1927, 1925.

[3] Campbell, W. C.: Bone-block Operation for Drop Foot; Analysis of End-results. Jour Bone and Joint Surg., vol. 12, p. 317, April, 1930.

[4] Contargyris, Ath.: Correction of Drop Foot by Posterior Arthrodesis. Jour. Bone and Joint Surg., vol. 5, p. 13, No. 1, January, 1931.

[5] Snow, Lawrence: Mechanical and Anatomical Principles of Operations for Drop Foot. Surg., Gynec., and Obstet., vol. 5, p. 51, No. 2, August, 1930.

[6] Wagner, Lewis Clark: Modified Bone Block (Campbell) of Ankle for Paralytic Drop Foot (with a Report of Twenty-seven Cases). Jour. of Bone and Joint Surg., vol. 5, p. 13, January, 1931.

CYSTOSCOPY AND UROGRAPHY

By Jarratt P. Robertson, M.D.,

and

A. B. Lee, M.D.

of Birmingham, Ala.

from the urological service, hillman hospital, birmingham, ala.

The combined and separate use of the cystoscope and X-ray have removed from uncertainty the diagnosis and treatment of many pathological conditions of the urinary tract. No longer need one debate, theorize, and speculate as to the rôle the urinary tract is playing in the pathology present. In most instances, cystoscopy and urography will either prove it innocent or guilty of the charges preferred. If the urologist makes use of all the armamentarium that is at his disposal, there are few fields in medicine that can boast of a higher percentage of correct diagnoses. Of these aids, the cystoscope and X-ray stand preëminent. They are indispensable to the urologist, and have made surgery of the kidney, ureter, and bladder definite, planned procedures. Seldom is it necessary, except in case of an emergency, to operate without knowing in advance what the procedure is to be. A nephrectomy is no longer performed without knowing that the remaining kidney is capable of sustaining life.

As in other branches of medicine, details must not be overlooked, the examination must be thorough and complete if our errors in diagnoses are to be reduced to a minimum. A complete and well-taken history as well as a general physical examination should precede cystoscopy. In certain instances it will be necessary to prove that frequency of urination is not due to a nephritis or diabetes before instrumentation is warranted.

In the female only a catheterized specimen of urine should ever be examined for pus, blood, or bacteria. It is a waste of time of all concerned to study a voided specimen of urine in the female. Before cystoscopy is performed in the female, the urethra should be milked to determine if an acute urethritis is present, and a vaginal or rectal examination made to rule out pathology of the reproductive organs. Pressure of the pregnant uterus, carcinoma of the cervix, as well as specific and nonspecific infections of the adnexa may account for symptoms referable to the bladder and at times to the ureter and kidney.

If pus is found in the urine of the male, that in itself does not necessarily mean that cystoscopy is indicated. Often the urethra, seminal vesicles, and prostate must prove their innocence before one is justified in performing cystoscopy to convict the kidney of being the organ guilty of supplying the pus.

Pain in the low lumbar region that the layman usually attributes to the kidney is due, in most instances, to a sacro-iliac strain, salpingitis, cervicitis, verumontanitis, and prostatitis. The pain is increased by standing, walking, and bending, but rest in bed gives considerable relief. Many of these patients will be improved by local treatment and unbenefited by cystoscopy.

If X-rays of the urinary tract are to be accurate and the diagnoses derived from them reliable, then the patient must be carefully prepared. This is done, in order to free the intestinal tract of all gas and fecal material. A laxative of petrolagar or compound licorice powder should be given the night before the X-rays are to be made. The following morning breakfast is omitted and an enema given. The enema is repeated if the intestinal tract is not free of gas.

Regardless of how painstaking the technician is in making the plates, how well trained the röntgenologist is in interpreting them, and how expensive the equipment employed, they cannot compete with an intestinal tract filled with gas and fecal material.

An infection of the kidney usually means a stagnation or obstruction to the outflow of urine. The obstruction may be at any point from the urethral meatus to the kidney pelvis. If an obstruction is not present causing a stagnation of the urine, the infection in the majority of instances will clear up in a few days. Examination will usually show the ureter to be the seat of the obstruction. (Fig. 1.) It may be due to a calculus, accessory blood-vessels at the lower pole of the kidney, adhesions, pelvic inflammatory conditions, pregnancy, intra- or extra-urinary tract tumors, congenital deformities, bladder-neck obstruction or stricture of the urethra.

Ureteral obstruction cannot be positively demonstrated except by ureterograms. Pyelography is contra-indicated in acute kidney infections, calculus completely blocking the ureter, and large hydronephrosis unless the catheter is left in place to assure drainage. Bilateral pyelograms and ureterograms are without danger if properly made. If the pyelographical fluid is not injected under force sufficient to cause an increase in the intrarenal pressure, then no alarming reaction need be anticipated. The reactions of cystoscopy are mainly dependent upon the amount of trauma produced. Bilateral pyelograms with a minimum of trauma produce far less reaction than simple ureteral catheterization with a maximum of trauma.

Reactions are prevented by gentle instrumentation. The brutal passage of instruments and reactions go hand in hand. The use of pantopon or morphine, and nupercaine 1–500 in the urethra greatly reduces the pain accompanying cystoscopy. This renders the patient more coöperative, there is less straining, and the trauma incident to instrumentation is reduced. A reduction in trauma means a decrease in the number of reactions following cystoscopy and urography. We are all familiar with the fact that fewer reactions follow instrumentations performed under sacral, spinal or general anæsthesia than when performed without anæsthesia. The reduction in the

number of reactions is due to the marked decrease in trauma made possible by the relaxation produced by the anæsthesia.

If cystoscopy and urography are performed in the following manner, it is seldom that additional X-rays will be needed for diagnostic purposes. Both ureters are catheterized, care being taken that the catheters are not inserted far enough to traumatize the kidney pelvis. The catheters are left in place and the cystoscope removed. This is greatly appreciated by the patient. Specimens of urine are collected from each catheter to determine if an infection is present. Five cubic centimetres of indigocarmine are given intravenously to determine the comparative function of the two kidneys.

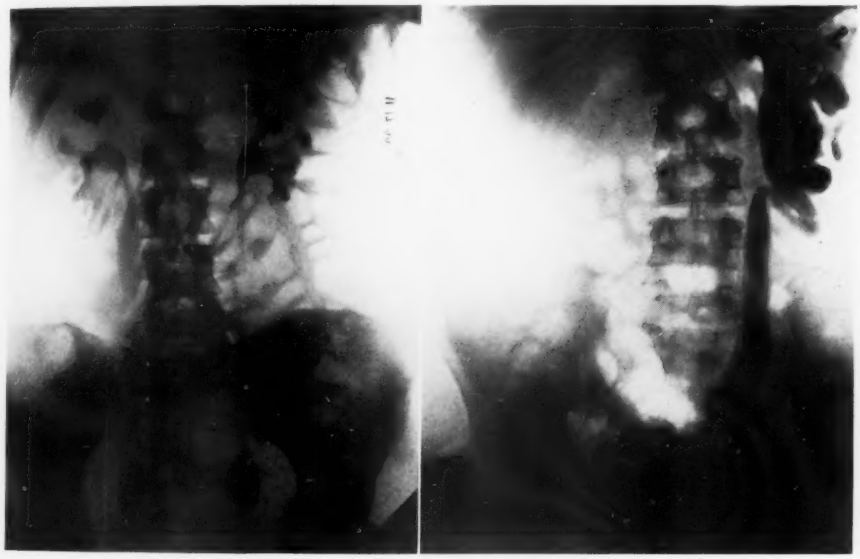


FIG. 1. FIG. 2.

FIG. 1.—Ureteropyelograms in a case of bilateral stricture in the extreme lower portion of the ureters. Note the marked dilatation of the ureters proximal to the strictures. The strictures were secondary to an extensive pelvic inflammatory disease.

FIG. 2.—A ureteropyelogram in a case of stricture of the juxtavesical portion of the left ureter. Note marked dilatation of ureter and renal pelvis proximal to the stricture. Urine loaded with pus. Due to marked cystitis right ureteral orifice could not be located and failed to secrete indigocarmine. Unable to demonstrate right kidney and ureter by use of intravenous pyelography. The primary pathology in this case was a congenital contracture of the bladder neck that was relieved ten years previously by an operation.

The function is determined by noting the appearance time and density of color of the indigocarmine as it drains from each catheter. This is much faster and in most instances just as accurate a determination of the function of the kidneys as is the phenolsulphonphthalein test. Its one failure is in the infantile kidney, but this type of kidney is demonstrated by the pyelogram. The combined function of the two kidneys is determined by the phenolsulphonphthalein test and the blood-chemistry readings. If a hydronephrosis is suspected, the capacity of the kidney pelvis is first determined by filling it with sterile water (Fig. 2). A 25 per cent solution of sodium

iodide is used as the pyelographical media. Only five cubic centimetres of this solution are injected into the kidney pelvis unless a hydronephrosis is present. This is not an amount sufficient to raise intrarenal pressure, but with the residual urine present will be sufficient to fill the kidney pelvis. There are many advantages in using a concentrated pyelographical media. Chief among these is a decrease in the renal colic produced by injecting large amounts of a weaker solution. The colic is due largely not to the irritation of the solution but to the increased intrarenal pressure, and the trauma incident to the passage of the catheter. With a concentrated media the X-rays are clearer and the details better preserved. If a unilateral pyelogram is desired, three cubic centimetres of the solution are injected into the opposite kidney to faintly outline the pelvis. This shows its size and position in case surgery of the diseased side becomes necessary.

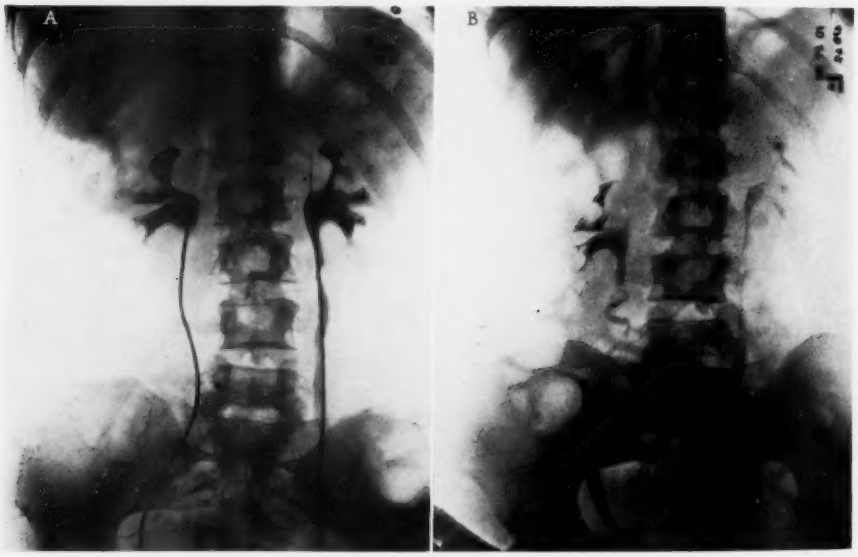


FIG. 3.—A bilateral pyelogram made with the patient in the horizontal position showing little evidence of nephroptosis. Note slight dilatation of left ureter. (B) Same case as in (A). Ureterograms made with patient in sitting position show nephroptosis, dilatation and kinking of ureters.

Four films are required in making X-rays. We have not been able to decrease this number without sacrificing information obtainable by cystoscopy and urography. The first plate is made with the catheters in place to determine if a calculus is present. For the second plate the patient is placed in Trendelenburg position and the pyelogram made. This not only shows the shape, size, and position of the pelvis but the height to which the kidney ascends. The third plate is made with the patient in the upright position. The catheters are removed and as they are withdrawn one cubic centimetre of the solution is deposited in the upper and lower thirds of the ureter. This shows the position of the kidney and ureter in the upright position, demon-

strating if there is ptosis of the kidney or a kink, sagging, angulation, dilatation, stricture, or other pathology of the ureter present. (Fig. 3A and 3B.) Seven minutes are allowed to elapse before the fourth plate is made. This is the normal emptying time of the ureter and pelvis. In this time the pyelographical media should have been expelled from the ureter and kidney pelvis if there is no obstruction present and peristalsis is normal.

Stricture of the ureter has been and probably will for years remain one of the most debated points in urology. There is a wide variation of opinion as to what constitutes a stricture of the ureter, how it is diagnosed, what are its symptoms, and when is it cured? These questions cannot be answered until an agreement is reached as to what constitutes a normal ureter.

Strictures of the ureter are caused in most instances by an ureteritis. The process may be intra- or extra-ureteral in origin. The tubercular stricture secondary to an acid-fast infection of the kidney is an illustration of a stricture due to an intra-ureteral infection. Strictures secondary to inflammatory processes involving the broad ligaments, adnexa, and lymphatics surrounding the ureter are due to extra-ureteral infections. Congenital strictures of the ureter do occur but very infrequently. Attempts are made to explain all strictures on this basis. Congenital strictures of the urethra are very uncommon. Then why should nature pick on the ureter and here produce a stricture while it passes up the urethra and intestinal tract, both of which are hollow tubes lined with a mucous membrane?

The symptoms of stricture of the ureter are those produced by an obstruction to the outflow of urine. There is usually a dilatation of the ureter and an infection of the kidney present. The infection may be severe or mild. In most instances it is mild. A pain, dull and aching in character, is usually associated with the stricture. It may occur at any point along the ureter but is most often located in the kidney region. The kidney pain is probably due to the increased intrarenal pressure and infection.

Calculi are especially prone to develop where there is an obstruction to the outflow of urine. This is more often true if an infection of the kidney is present. Free drainage, the maintenance of a highly acid urine, forced fluids, and the liberal use of urinary antiseptics is all we have to offer these patients to prevent the recurrence of their stones.

The normal ureter should permit the passage of a No. 7 or 8 F. bougie. Pyelography will often demonstrate that the obstruction encountered is not due to a stricture but to a kinking and angulation of the ureter. The catheter fails to pass not because the lumen of the ureter is too small to permit its passage but because the tip is obstructed by an acute angulation of the ureter. If the catheter passes beyond this point, it will be found easily to enter the kidney pelvis. Upon withdrawing it no change can be made out. Placing the patient in the Trendelenburg position and allowing the kidney to ascend and straighten out the ureter will cure many strictures diagnosed without the bulbous bougie and ureterogram. In many cases of kinks and angula-

tions of the ureter, urography will show the kidney pelvis and ureter to empty within normal limits, and fail to reveal any evidence of back pressure. We do not feel that a diagnosis of stricture should be made unless a definite obstruction is encountered in the passage of catheter or bougie and that a constriction of the ureter can be demonstrated with the ureterogram (Fig. 4).

The treatment of stricture of the ureter is the same as the treatment of any other stricture, dilatation. Unless a calculus is or has been present, we do not feel that it is necessary to dilate the ureter to more than a No. 10 or 12 F. calibre. If a calculus has formed, then the ureter should be dilated to a No. 14 or 16 F. calibre.

The treatment of kidney infections depends upon observing the following

FIG. 4.

FIG. 5.

FIG. 4.—Stricture of right ureter. A ureterotomy had previously been done to remove a calculus from this area. Note the retained pyelographical media. This plate was made seven minutes following the removal of the catheter. Following the dilatation of the stricture to a No. 12 F. the pus disappeared from the urine.

FIG. 5.—Pyelograms in a case of pregnancy complicated with a bilateral kidney infection. Note marked dilatation of pelves and ureters to pelvic brim. This case was very successfully treated with indwelling ureteral catheters. At the end of seven days the catheters were removed.

laws: (1) The relief of any obstruction that might cause a stagnation or retention of urine. If the infection lasts longer than three or four weeks, some obstruction to the outflow of urine is probably present. (2) A fluid intake of 3,000 to 4,000 cubic centimetres per twenty-four hours. Fluids must be forced until the infection is literally washed away. (3) The liberal use of urinary antiseptics. They are of much greater value when used prophylactically to prevent an infection than when used as a treatment to cure an infection that is already established.

Numerous new urinary antisceptics have been introduced from year to year. Only one of them has been able to stand the test of time, urotropin

and acid sodium phosphate. There must be some virtue in a drug to which year after year we return. The increase in the acidity of the urine is just as important in combating the infection as is the use of the urotropin, and is probably of more benefit by itself than the use of urotropin alone.

In the treatment of urinary tract infections, we prefer to start with urotropin and acid sodium phosphate giving from 45 to 60 grs. of each every twenty-four hours for six or seven days. It is then discontinued and an alkali given for four or five days. The change of the reaction of the urine from acid to alkaline inhibits the growth of certain bacteria. This routine with a fluid intake amounting to three of four thousand cubic centimetres each twenty-four hours will give consistent and satisfactory results in the treatment of urinary tract infections where marked obstruction is not present. Our results with serenium, pyridium, niazo, mallophene, and other drugs of this type have been disappointing.

Ureteral catheterization and irrigation of the kidney pelvis will cure many cases of pyelitis, not from the solution employed for the irrigation, but from the establishing of better drainage due to the passage of the catheter. (Autopsies in kidney infections often show the parenchyma to be studded with minute foci of infection.) Therefore, it is easy to see that the infection is not eradicated by the bacterial coefficient of the drug used, but by establishing better drainage and the mechanical cleansing of the kidney pelvis and in this way assisting nature to overcome the infection. Startling results often follow the use of the indwelling ureteral catheter where the patient is acutely ill and the ureter blocked. This is especially true in the kidney infections of pregnancy.

It has been definitely proved by intravenous and retrograde pyelography that the kidney pelvis and ureter of the pregnant woman become greatly dilated. After the fifth month of pregnancy we have found the right ureter and pelvis to be dilated in about 90 per cent. of the cases and the left in about 80 per cent. The dilatation is not dependent upon infection, as our cases were chosen from those without infection and where the previous history was negative for infection. Dilatation may be noted as early as the third and fourth months of pregnancy. If this residual urine becomes infected, drainage must be established if improvement is to be early, satisfactory, and consistent. The most satisfactory way of establishing drainage is with the indwelling ureteral catheter. (Fig. 5.) The catheters may be left in place for several weeks provided they are changed every four or five days. They should be irrigated every three or four hours. For this we prefer distilled water as it does not form a deposit and block the lumen of the catheter.

The passage of a calculus may be hastened by the introduction of a ureteral catheter or bougie. If the ureteral colic is severe or the patient septic, the catheter or bougie may be left in place. This dilates the ureter, moves the calculus, and gives it a new start on its way to the bladder. Also the retained pus and urine are allowed to drain from the kidney pelvis. This relieves the

pain and absorption that results from its retention. If a catheter can be passed by the calculus, several things are accomplished at the same time. (1) The pain is relieved as it is due more to the increased intrarenal pressure than to the passage of the calculus. (2) The universal infection that accompanies the blockage is combated. (3) A pyelogram can be made and this will show the amount of dilatation of the ureter and kidney pelvis above the calculus. (4) A kidney function test may be done to determine the amount of damage suffered by the kidney. (5) The ureter is dilated so that upon the removal of the catheter the passage of the calculus is facilitated.

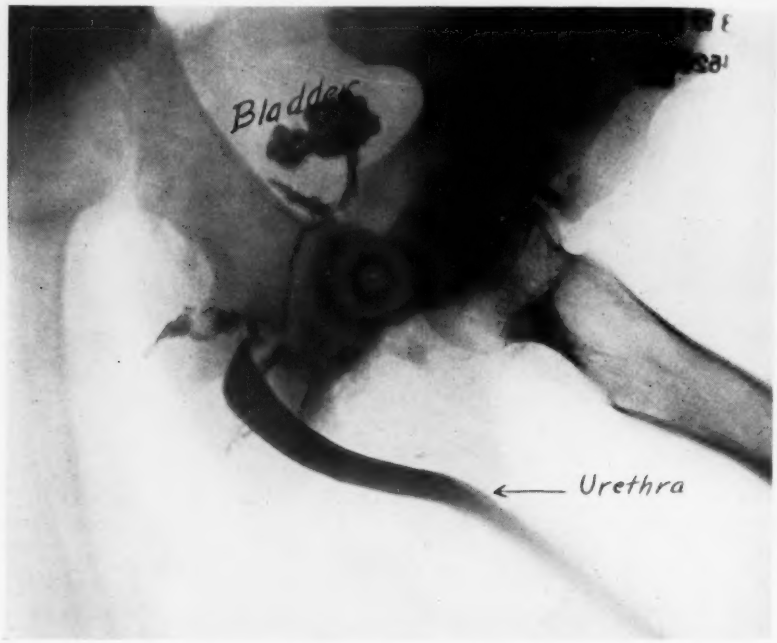


FIG. 6.—A urethrogram in an old fracture of the pelvis with injury to the urethra. Note strictures and multiple fistulæ in the posterior urethra.

X-ray is too seldom used in the diagnosis of pathological conditions of the bladder and urethra. By the use of cystograms, and airgrams, diverticula, tumors, calculi, and reflux of urine up the ureter can be demonstrated. The size, shape and protrusion of the prostate into the bladder are easily seen. In this way an accurate picture of the pathology present can be preserved. We employ a 5 per cent solution of sodium iodide in making a cystogram. Using a weak solution of this kind, the intrusion of the prostate and tumors into the bladder as well as the increased density produced by the filling of a diverticulum can be demonstrated.

A urethrogram made in conjunction with a cystogram gives a complete picture of the lower urinary tract. We have found iodochloral (G. D. Searle & Co.) diluted from one-half to one-third of its original strength with cotton-

seed oil to be a satisfactory opaque media to use in making urethrograms. (Fig. 6.) From twenty to forty cubic centimetres of the solution are required for an injection.

The practical clinical application of a urethrogram is in demonstrating the size, shape, and position of strictures and fistulæ of the urethra, as well as the shape, size, and length of the prostate. This is important in studying the prostatic urethra before and after prostectomy and prostatic resection. In cases of incontinence it is possible to demonstrate if the external sphincter is intact or has been destroyed. It will also show the relaxed internal sphincter that accompanies the neurological bladder.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD OCTOBER 10, 1934

The President, DR. ALLEN O. WHIPPLE, in the Chair

PRIMARY JEJUNAL ULCER

DR. BEVERLY C. SMITH presented a man, aged 27, first seen in April, 1925, at which time he appeared to be suffering from a chronic arthritis; infected teeth and tonsils were removed; some improvement but not complete. One month later, he was treated for thrombo-angiitis obliterans. Gangrene occurring in toes necessitated a primary peri-arterial sympathectomy on his right common femoral artery in September, 1925, and a subsequent mid-thigh amputation a week later. In September, 1928, the left leg was affected, for which a peri-arterial sympathectomy was done on the left common femoral artery, following which he began, for the first time, to complain of stomach trouble. It was found, however, that two years previously he had noticed some epigastric distress greatly aggravated by food. These attacks occurred intermittently and were relieved by induced vomiting. In April, 1929, stools were positive for occult blood; blood count was normal; gastric analysis free hydrochloric acid 5, total acidity 20, negative for blood. Gastro-intestinal series showed normal stomach and duodenum. Cholecystogram negative. Symptoms at this time still consisted of epigastric pain increased by ingestion of food and nausea. He was treated as a case of duodenal ulcer with moderate improvement.

July 26, 1929, he was re-admitted to Presbyterian Hospital acutely ill, complaining of sudden onset of abdominal pain 17 hours previously, beginning in lower left epigastrium and radiating to left lower quadrant. It had been continuous since onset and increasing in severity accompanied by vomiting. Temperature 99°, pulse 100, respirations 18. He was apparently in extreme pain, pallid and obviously shocked. The abdomen presented boardlike rigidity, marked hyperesthesia of skin over left half of abdomen and an area of maximum tenderness three centimeters lateral and two centimeters below and to the left of the umbilicus. There was some apparent diminution of liver dulness; white blood cells 20,000, polymorphonuclears 88 per cent. Diagnosis, perforated duodenal ulcer.

Operation 18 hours after onset of acute illness. Gas-oxygen anesthesia. There was a very moderate amount of thin, odorless exudate noted. On examination a perforation two by two millimeters with slight eversion of the indurated mucosa was found on the antimesenteric border of the jejunum two feet below the ligament of Treitze which was partially sealed off by adjacent intestinal loops. There were no evidences of disease of any other intra-abdominal viscera or of the mesenteric vessels. Perforation of the jejunum was closed. There was no drainage of the abdominal cavity. Culture of exudate was negative. Convalescence was uneventful. Repeated follow-up examinations during the past five years have been normal at all times. He has gained 45 pounds and eats everything. He is still under treatment for the thrombo-angiitis obliterans in his remaining leg.

This case was of interest because single primary jejunal ulcers occurring

in patients who have had no previous abdominal operation are rare. An extensive survey since 1827 shows but 25 cases, this being the twenty-sixth.

The persistence of pain in the lower left epigastrium and radiation into the lower left quadrant, its definite reference to these regions at the time of perforation with an hyperesthesia of the skin of this region, are distinctly different from what is usually seen in cases of perforated duodenal ulcer.

The diagnosis of this lesion is essentially difficult. Where a peritonitis of undetermined origin is encountered, the entire small bowel should be carefully examined as several of these cases have been explored without the cause of the peritonitis having been determined, the small bowel not having been examined in its entirety and the true condition having been discovered at autopsy.

Of the 25 cases previously reported in the literature, 19 were operated upon with a mortality of 47.3 per cent; the mortality of the entire group was 61.55 per cent.

There apparently has never been a preoperative diagnosis of an unobstructed unperforated case with this lesion.

The absence of visible evidence of disease of the mesenteric or intestinal vessels and the complete absence of symptoms for five years postoperatively makes it improbable that the coexistent thrombo-angiitis obliterans was an etiologic factor in either the formation or perforation of his primary jejunal ulcer.

Dr. W. Howard Barber said that he reported a case of jejunal ulcer not associated with gastrojejunostomy in the Annals of Surgery October, 1926, pp. 621–622. This man, a cook, 33 years old, gave a history of two previous operations for ulcer of the stomach, in 1917 and 1921, respectively. He came under Doctor Barber's care in 1926 for what appeared to be an acute perforated duodenal ulcer but which proved to be an acute perforated and indurated ulcer in the postgastric jejunum. The jejunal loop was directed obliquely downwards instead of horizontally to the left by the inflammation about the perforation. There were adhesions about the gallbladder and an acute appendicitis. The ulcer was closed, posterior gastrojejunostomy and appendectomy were carried out. He made an uneventful recovery, was discharged from Jamaica Hospital in three weeks, and remained symptom-free while under observation during the succeeding four months. Appendiceal infection was suggested as the possible etiologic factor. In regard to the incidence of primary jejunal ulcer or ulcer not associated with gastrojejunostomy, Doctor Symmers, reporting for Bellevue Hospital, according to Doctor Barber, gave the following statistics: "In 17,518 autopsies, primary jejunal ulcers were found in 16 instances. Of these, 12 were tuberculous; two were nonspecific, that is to say, there was nothing in the microscopic examination or in the autopsy to indicate the cause of the lesion; one was associated with endocarditis and was assumed to be of embolic origin and one occurred as an incidental finding in a case of leukemia."

JEJUNAL ULCER FOLLOWING GASTRO-ENTEROSTOMY FOR DUODENAL ULCER

Dr. Beverly C. Smith presented a man, aged 34, who had been operated upon 16 years previously for acute appendicitis, at which time a pure growth

of pneumococcus IV was isolated from the appendix. In 1927, he complained of epigastric distress one to two hours after meals which was relieved by food and soda, with occasional nausea and vomiting, some loss of weight and appetite. A gastro-intestinal series confirmed clinical diagnosis of duodenal ulcer. At this time, gastric analysis showed free hydrochloric acid 84, total acidity 98. On proper diet and alkaline medication, he was symptom-free for one year, when he suffered an acute hemolytic streptococcus tonsillitis with abscess formation followed by septicemia and lobular pneumonia, left lower lobe abscess and multiple skin abscesses. Because of his inability to adhere to his restricted diet and because of increased epigastric discomfort and an increasing size of his duodenal ulcer as evidenced by roentgen ray, he was operated upon March 22, 1932, at which time a posterior gastro-enterostomy was done and an entero-enterostomy with Murphy button. He was relieved of his discomfort for eight months when, after further dietary indiscretions, he had a renewal of epigastric discomfort. The character of this, however, was different from his preoperative complaint in that it was situated lower and more to the left of his epigastrium, it occurred irregularly and was not relieved by food or soda as previously and radiated to the left lower quadrant. It was described as griping and accompanied by desire to defecate; was usually relieved by passage of a watery stool and flatus. For the following six weeks, he would have three or four such attacks a day. The gastric analysis at this time showed free hydrochloric acid 10, total acidity 30. A gastro-intestinal series showed a jejunal ulcer in the distal jejunal loop three centimeters distal to the gastro-enterostomy stoma and two centimeters proximal to the enter-enterostomy stoma. A laparotomy showed a jejunal ulcer in exactly this position which had perforated into the transverse mesocolon, culture of which showed a hemolytic streptococcus and *Staphylococcus aureus.* The ulcer in the jejunum was closed with catgut and the abscess site peritonealized. The original duodenal ulcer was apparently healed and inactive. The peritoneal cavity was not drained. Convalescence was uneventful but for two months postoperative he had a return of his preoperative symptomatology to a much less degree. On careful dietary restriction and alkalinization, these symptoms were relieved and he has now remained well for the past 18 months.

This case is reported because of the onset of ulcer symptoms at the age of 13 years and their continuance for 18 years.

Because of his ability to control his discomfort on dietary régime and the recurrence of symptoms when it was disregarded even after being symptom-free for two years.

Occurence of a jejunal ulcer in the distal loop of the gastro-enterostomy, proximal to an entero-enterostomy and the reduction of free hydrochloric acid from 84 to 10 after primary gastro-enterostomy.

Perfection of a secondary jejunal ulcer and a culture of the hemolytic streptococcus and *Staphylococcus aureus* at site of perforation.

His freedom from symptomatology for last 18 months.

The succession of bacteriologic findings with a pure pneumococcus IV from his original appendix operation. The hemolytic streptococcus bacteremia following tonsillitis. The hemolytic streptococcus from the abscess about the jejunal ulcer perforation and a subsequent streptococcus sinusitis following a tonsillectomy in 1934.

Dr. Richard Lewisohn stated that he wondered whether primary gastric resection might not have been the better procedure in this case. In many patients gastro-enterostomy is not a simple operation. Doctor Smith had

said that on account of the high position of the stomach he had to add an entero-anastomosis. It is possible that the jejunal ulcer is still more or less active although at present in a quiescent stage. It might be well for Doctor Smith to consider what should best be done in the event of a recurrence. These ulcers have a life cycle just the same as duodenal ulcers; they can remain quiescent for many months and then flare up again suddenly.

DR. J. WILLIAM HINTON said that Doctor Smith had asked him to look up the records of secondary jejunal ulcer following gastro-enterostomy in the clinic of the Fourth Division of Bellevue Hospital. The classification, as to whether they should be called secondary jejunal ulcers or gastrojejunal ulcers, was a matter for debate. There had been a total of 16 cases in the clinic; eight were operated upon and eight were not. Of the latter the roentgen ray department had reported that four were true marginal ulcers and four had ulcers in the distal loop of the jejunum. There was none in the proximal loop. Of the operated cases, there were three in the distal loop at a distance of one-half inch to one and one-half inches from the stoma. Of these three cases it is interesting to note that one patient had had two perforated jejunal ulcers following a pylorectomy which was done in 1928. The first perforation was in the distal loop of the jejunum one inch distal to the stoma. The second perforation which took place approximately one and a half years after the first one was in the jejunum about one-half inch distal to the stoma. Two patients had jejunal ulcer opposite the stoma; one being on the anterior portion of the jejunum and adherent to the colon, the other being on the posterior portion of the jejunum and adherent to the pancreas. There were two patients that had the ulcer directly on the anterior margin of the stoma and one patient had an ulcer completely on the gastric side opposite the stoma but on the posterior wall of the stomach and was adherent to the pancreas. In none of the cases did we find an ulcer as far distal to the stoma as the case Doctor Smith reported in which the ulcer was approximately three inches from the stoma.

DIAPHRAGMATIC GASTRIC HERNIA WITH CALLOUS ULCER

OPERATIVE REDUCTION

DR. DEWITT STETTEN presented a man, aged 51, referred by Dr. Max Einhorn, complaining that for about five years he had been troubled with flatulence and indigestion, and for the past two years had noticed some difficulty in swallowing. In August, 1933, after lifting a heavy weight, he felt pains in the epigastrium, which gradually increased. He vomited occasionally, especially after breakfast. Has never been jaundiced, vomited blood, nor passed tarry stools. During the past two months his symptoms had become more pronounced with loss of about ten pounds.

Examination showed a heavy, thick-set male, with slight tenderness and resistance in the epigastrium. A duodenal tube could be swallowed, but it was impossible to pass an ordinary esophageal bougie past the cardia. Blood count normal. Roentgen ray examination by Dr. William H. Stewart showed a definite cardiospasm and narrowing of the lower portion of the esophagus,

with some dilatation above and considerable retention. As the meal entered the stomach, an irregular egg-shaped pouch was noted, apparently on the lesser curvature above the level of the left dome of the diaphragm, and in front of the esophagus. The material from this pouch eventually emptied into the stomach. A small retention shadow at the neck of the pouch was noted in the oblique position, although not recognized at the time of the roentgen ray examination, was subsequently proven to be an ulcer crater at the neck of the hernial protrusion (Fig. 1).

A diagnosis of diaphragmatic hernia of the cardiac portion of the stomach with cardiospasm was made. Operation February 14, 1934, general anesthesia.

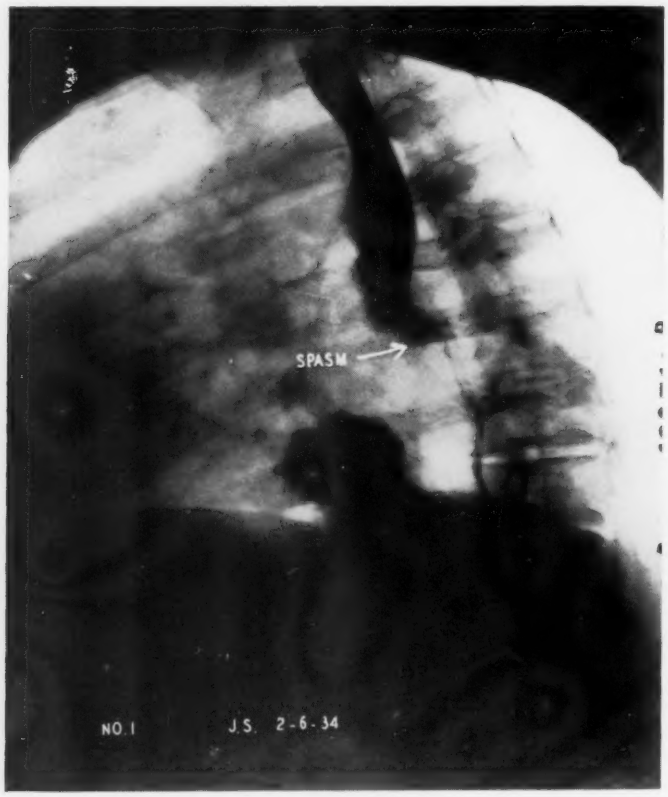


FIG. 1.—Radiograph, February 6, 1934, showing cardiospasm and diaphragmatic gastric hernia of lesser curvature in front of esophageal opening.

Median epigastric incision. The stomach was relatively small and high up under the liver and diaphragm. In front of the esophageal opening was a circular defect in the left dome of the diaphragm with hard, sharp, tense, rigid edges, like a steel ring, and with a diameter of about two and one-half inches. Through this defect extruded a rather firmly adherent pouch of stomach springing from the lesser curvature just below the cardia. At the pyloric side of the neck of this pouch on the lesser curvature was a hard, indurated, circular area about three-quarters of an inch in diameter, which had all the appearances of an indurated callous ulcer; on palpation from the gastric side a definite circular crater could be felt in this area, into which the tip of

the thumb could be inserted. The crater was about three-eighths of an inch deep (Fig. 2). When this indurated area was withdrawn from the edge of the diaphragmatic hernial cavity, it could be exposed to view and its serous surface was seen as an intensely reddened, somewhat umbilicated area, just below the lesser curvature. It had all the characteristics of a benign lesion and there were no evidences of any enlarged lymph glands or metastases. It was possible to separate the adhesions holding the pouch of stomach in the diaphragmatic hernia, and to reduce it with the ulcerated area entirely into the abdomen. The diaphragmatic opening was quite inaccessible to suture, the edges were so firm and rigid, and the opening so wide, that even if it could have been reached, it was extremely doubtful whether the opening could have been closed. Transthoracic exposure and fascial transplantation was deemed too difficult and serious a procedure. It was decided to employ the simple expedient of gauze tamponade of the hernial sac and allow the cavity to obliterate itself by granulation, thus keeping the pouch from the lesser curvature from reëntering the sac, permitting this portion of the stomach to become firmly adherent within the abdominal cavity and allowing

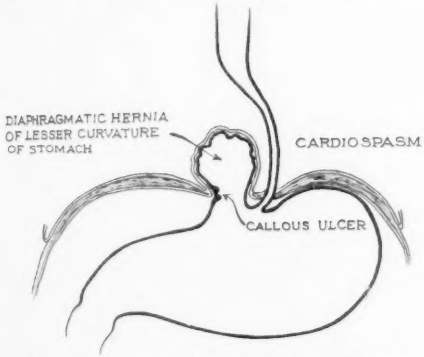


FIG. 2.—Diagram of condition found at operation showing hernia of lesser curvature of stomach through defect in diaphragm in front of esophageal opening, with callous ulcer at neck of hernial protrusion.

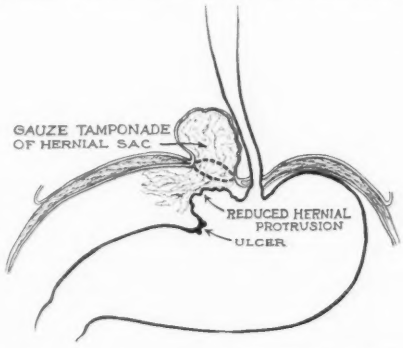


FIG. 3.—Diagram of operative procedure showing reduction of hernial protrusion and gauze tamponade of hernial sac.

the ulcer to heal. Seven gauze tampons tightly filled the hernial sac and effectively kept the stomach pouch in the abdomen (Fig. 3). The tampons were surrounded with rubber dam. Nothing was done to the ulcer itself, as it was felt that it would heal promptly if the traumatism and circulatory disturbance from the ring of the hernial opening were removed.

The patient's convalescence was unusually smooth. The dysphagia and regurgitation were immediately relieved and the epigastric pain disappeared. The gauze tampons were gradually loosened after 17 days, and the last removed on the twenty-second day. Roentgen ray examination one month after operation showed the gastric hernia completely reduced. There now remained only a small, nipple-like projection of the stomach at the cardia, and there still appeared to be some spasm of the lower portion of the esophagus. The ulcer of the lesser curvature at the neck of the hernial protrusion found at operation was not demonstrated (Fig. 4). The last roentgen ray examination of the lower esophagus and stomach taken 57 days after operation revealed apparently normal outlines. The patient has remained perfectly well, is symptom-free, and has gained twenty-seven pounds.

The case is presented as an unusual type of diaphragmatic gastric hernia, involving the lesser curvature, through apparently what was a separate, prob-

ably congenital, defect in the diaphragm, with the additional complication of a callous ulcer at the neck of the hernial protrusion, probably caused by the traumatism and the circulatory disturbance from the constricting rigid ring of the hernial opening. The main symptoms in the case were produced by the accompanying cardiospasm, which may have been partly reflex and partly due to pressure from the hernial sac, or to actual distortion of the cardiac opening. The method of surgical relief was apparently the simplest and safest, though it is possible that it may not have succeeded in permanently obliterating the hernial sac by tamponade and healing by granulation, the procedure was quite

FIG. 4.—Radiograph, March 13, 1934, showing condition found after operation with diaphragmatic gastric hernia of lesser curvature completely reduced, persistence of nipple of stomach at cardia, and also persistence of some cardiospasm. No evidence of ulcer present.

effective and the danger of a recurrence is rather slight, as the chances are that the protruding portion of the stomach is now more or less permanently fixed by adhesions within the abdominal cavity. It would appear that the irritation from the ring of the hernial opening having been removed from the site of the ulceration has allowed the ulcer to heal.

DR. FRANK S. MATHEWS said that he and Doctor MacFee had reported two cases of this condition. The speaker's own case was a woman of 50 whose illness had been considered pernicious anemia because of long continuance of

the symptoms. The roentgen ray showed what proved to be an ulcer on the lesser curvature of the stomach at the level where the ring of the diaphragm constricted a gastric hernia. The ulcer was small, indurated and the greater omentum was adherent over it. There was a gastric residue in the stomach after nine hours. Because of obesity and other mechanical difficulties, the ulcer did not seem resectable. A gastro-enterostomy was performed because of the large residue and the patient is alive and free from symptoms after ten years though the hernia was not disturbed.

In diaphragmatic gastric herniae there will be found cases where roentgen ray shows no evidence of an ulcer yet an anemia and blood in stools would indicate that there is a congestion allowing bleeding in the herniated portion of the stomach.

Dr. William F. MacFee said that his patient had an unexplained anemia upon entering the hospital, and in the routine series of examinations diaphragmatic hernia was demonstrated. The patient died of hemorrhage from a gastric ulcer. The ulcer was found at autopsy on the lesser curvature opposite the hernial ring. In reporting a series of diaphragmatic herniae, Harrington, of the Mayo Clinic, observed secondary anemia in a number of them. A few had ulcer of the stomach at the hernial ring.

TORTION AND GANGRENE OF PORTION OF LESSER OMENTUM

Dr. DeWitt Stetten presented a woman, aged 33, who complained that six and four weeks previously she had had attacks of epigastric pain coming on a short time after meals, associated with some nausea but no vomiting. She had also had diffuse abdominal cramps and some diarrhea without blood or mucus in the stools. Examination at the time was entirely negative. These attacks subsided spontaneously. The patient was quite well again until four days before her present illness except that she had been running slight evening temperatures up to 101.2°. For the past four days she had been having steady pain in the upper abdomen, similar in character to that of the two previous attacks, but more persistent and radiating more definitely to the left side. There was no diarrhea; the patient was slightly nauseated but did not vomit. During the few hours just preceding examination, the pain had become very much more severe.

On examination the patient was found to be suffering considerable pain, but did not look extremely ill. There was boardlike rigidity of the greater part of the abdomen, particularly of the epigastrium, the left hypochondrium and the left lower quadrant. The right hypochondrium was also somewhat rigid, the right lower quadrant being the least rigid, though not absolutely soft. The rigid areas were all quite sensitive, particularly the epigastric region. On rectal examination there was some fulness and tenderness in the cul-de-sac, but no definite mass. The patient was menstruating. Pulse 120, temperature, 99.8°. Blood count: 7,000 leukocytes, 64 per cent polymorphonuclears, and 36 per cent lymphocytes. The patient was immediately operated on with the indefinite diagnosis of an acute abdomen.

Operation.—Under general anesthesia, the abdomen was opened in the lower median line. There was a moderate amount of free, serosanguineous fluid in the pelvis. The uterus, both tubes and ovaries were comparatively normal. The appendix was long, slightly thickened, with a somewhat scarred

tip, and contained about five fairly firm fecal concretions; it was removed. In the serosa of a loop of mid-ileum, at a point opposite the mesentery, was a small, white fibrous nodule the size of a small seed; this was excised for microscopic examination. There was no evidence of a perforating ulcer or diverticulum of the ileum or colon. There was no evidence of a Meckel's diverticulum. The incision was extended upwards above the umbilicus, and the stomach was inspected. Lying loosely adherent to the lesser curvature and anterior surface of the stomach, just about at the reëntrant angle, was a greenish-black, gangrenous mass of fat tissue, rather flat and about one and one-half inches in diameter. This was obviously a lipomatous outgrowth from the anterior leaf of the lesser omentum, which had become twisted and necrotic (Fig. 5). On separating this mass from the stomach, a definite pedicle could be seen springing from the anterior leaf of the lesser omentum, just above its attachment to the stomach. The serosa of the stomach, where the mass had been adherent, and the adjacent areas were markedly injected and infiltrated. There was absolutely no evidence of a perforating ulcer of the stomach, or of any ulceration or tumor of this organ or of the duodenum. After separating

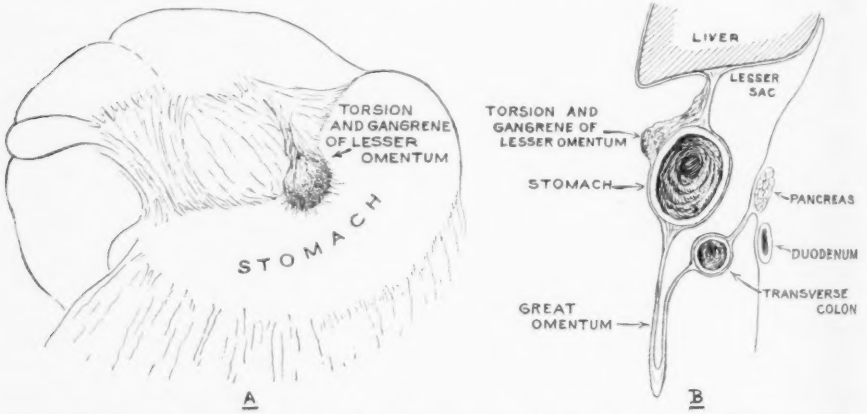


FIG. 5.—Torsion and gangrene of portion of lesser omentum. (A) Anterior view. (B) Transverse section.

the twisted, gangrenous mass from the stomach, the pedicle was ligated and the mass excised. Microscopic examination of the fibrous nodule from the mid-ileum showed it to be simple fibrous tissue, and the gangrenous piece of lesser omentum showed hemorrhagic infarction and necrosis. The convalescence and postoperative course were normal.

The pathology of this condition is not unlike that of torsion of a portion of the greater omentum or of the appendices epiploicae, which is relatively common, but in this instance the anatomic variation of a pendulous portion or pedunculated lipomatous mass growing from the anterior leaf of the lesser omentum must have been a prerequisite for the development of this pathologic curiosity. The condition, although obviously an extremely rare one, should be borne in mind in cases of acute upper abdominal disturbances.

PARATHYROIDECTOMY FOR RAYNAUD'S DISEASE AND SCLERODERMA

PRELIMINARY REPORT

DR. JOHN H. GARLOCK read a paper, written by himself and DR. ALICE M. BERNHEIM, with the above title, for which see p. 1012.

Dr. William Barclay Parsons said that although Doctor Garlock had mentioned employing the calcium tolerance test as a gauge of parathyroid function, it would be interesting to know in more detail why calcium balance studies had not been made, and exactly what was the nature and accuracy of the calcium tolerance test. It is an important point whether one considers Raynaud's disease and scleroderma, if in fact due to altered calcium metabolism, to be instances of true hyperparathyroidism or merely disturbed parathyroid function. In the body of his paper, he grouped Raynaud's disease, vasospastic conditions, many cases of persistent renal calculus, and cases of von Recklinghausen's disease, all under the heading of hyperparathyroidism.

Hyperparathyroidism, as shown by a high serum calcium, low serum phosphorus, and elevated phosphatase, and a negative calcium balance, is a distinct picture. In true hyperparathyroidism, as exemplified by von Recklinghausen's disease, there is a definite group of symptoms, and distinct evidence of the withdrawal of calcium from the bones. In the absence of what has come to be accepted as clinical evidence of hyperparathyroidism, is one entitled to make such a diagnosis? In view of the experiments of Selye and the reported cases of Leriche, Ballin and others, we have been interested in this subject at the Presbyterian Hospital; and Doctor Gutman, in studying the blood chemistry in cases of scleroderma, has found the calcium, phosphorus, and phosphatase within normal limits. Adolph Jung, at Strassburg, in his excellent monograph on Surgery of the Parathyroids, takes up parathyroidectomy for scleroderma. He comes to the conclusion that in cases of scleroderma with an elevated blood calcium level, one could expect good results from parathyroidectomy, but also cites a case where ligation of the inferior thyroid artery was successful. It is conceivable that in this case the blood supply to the inferior parathyroid was interfered with. There can be no question as to the results that Doctor Garlock reported. They were striking. But the speaker felt that the rationale for parathyroidectomy in these cases was a little obscure. None of them gave evidence of hyperparathyroidism. If Doctor Garlock meant to show that they were merely cases of disturbed parathyroid function, that was quite different. If it was intended to show that they were cases of hyperparathyroidism, Doctor Parsons hoped that in future studies a little clearer proof of this might be given.

Dr. Emil Goetsch said that the interesting results reported by Doctor Garlock in the treatment of certain cases of Raynaud's disease, arteriosclerosis and Buerger's disease, had opened a new field in the possible treatment of these distressing conditions. The clinical results indicate that something beneficial has been accomplished. Doctor Goetsch was confused, however, as it seems Doctor Parsons was, in attempting to understand the rationale and the physiologic reasoning pertaining to the possible benefits derived by parathyroidectomy. If, as was indicated, the vasospasm is due in the first instance to deficiency of calcium, then it would seem paradoxical to attempt an increase of blood calcium by the removal of the parathyroids, a procedure which one

would think would lead to an even greater deficiency of calcium. If, on the other hand, the deficiency of calcium was remedied by parathyroidectomy, then there should be no need of a high calcium diet and calcium therapy after operation. One would be inclined to think that the improvement noted after parathyroidectomy in the cases reported might be due more to the high calcium intake after operation than to the operation itself. A critical test would be to omit the high calcium intake after and to note whether improvement follows parathyroidectomy itself. Doctor Garlock's reasoning seemed very paradoxical. However, one's interest is aroused by the results obtained regardless for the present of the explanation therefor. The final results certainly were most encouraging.

Dr. Russel H. Patterson said that in this type of disease, namely, scleroderma, there are pathologic changes involving several different parts of the body. There seem to be parathyroid changes, there are local changes, there are sympathetic ganglion or vasomotor changes and there may be an altered mineral metabolism.

Doctor Garlock has attacked the disease by removing some of the parathyroids and his results have been demonstrated and speak for themselves. Dr. Alice Bernheim has seen some cases improve greatly in her clinic by increasing the calcium in their diet.

I became interested in the disease some three years ago. Because of the fact that there were associated vasomotor changes I blocked the sympathetic ganglia of the extremities with first procaine and then alcohol. In two or three cases considerable improvement followed. I have resected the sympathetic ganglia and found considerable improvement in two cases. One case, in whom I have been jointly interested with Dr. W. D. Andrus, had very marked scleroderma of hands, feet and face. Doctor Andrus resected the sympathetic ganglia of the upper extremities and I blocked the ganglia to the lower extremities. Improvement followed and the patient was encouraged, but recently I have seen her and the condition has recurred. The ganglia in her case showed very marked degenerative changes. Ganglia removed in a similar case at Johns Hopkins showed marked degenerative and pathologic changes. It has been quite evident that in addition to the sympathetic ganglion changes these patients all seem to be of a type, namely, suffering from marked loss of weight, marked loss of appetite and general asthenia. The picture therefore resembles very much the so-called alcoholic neuritis and other vitamin deficiency diseases. Attacking the problem in this way the group at the New Haven Hospital gave such a patient a very high vitamin B diet over a period of months. Marked improvement occurred.

It is thus seen that the relationship between glands of internal secretion, mineral metabolism, sympathetic nervous system and vitamins are not clearly understood. There seems to be a close relationship of these parts of the body and interrupting the chain at one point seems to benefit one case, while interrupting it at another seems to benefit another.

DOCTOR GARLOCK, in closing the discussion, stated that he did not mean to give the impression that this entire problem had been settled by the presentation of the facts in his paper. On the contrary, he felt that this was only a beginning of what might very well turn out to be a complicated and interesting question. He stated that surgeons at the present time are in some sort of a similar situation with regards to the parathyroids as were the surgeons of forty and fifty years ago with respect to disturbances of thyroid physiology. He hoped that further studies would clarify the situation more completely.

In reply to the remarks of Doctors Parsons and Goetsch, Doctor Garlock stated that calcium balance studies were not made in these cases because the total amount of calcium in the blood was found to be within normal limits. Consequently, no significant changes could be expected in calcium excretion. He wished to state quite emphatically that normal total calcium of the blood does not rule out disturbances of calcium metabolism or disease of the parathyroid glands. This statement is strengthened by the fact that there are several forms of calcium in the blood and imbalances may exist among them without alterations in the total content. For instance, in certain cases of allergy the total calcium has been found to be within normal range while the diffusible portion is increased. In the presence of marked bone decalcification the total calcium in the blood may be within normal limits. It is a well-known fact that a constant flow of calcium from the bones to the blood is controlled by the parathyroid glands. With long deficiency in calcium intake, these glands have been found to be hyperplastic, apparently because of their increased physiologic activity in withdrawing calcium from depleted bones, and the result is that the total calcium content of the blood remains within normal limits. There is no internal circulation, so to speak, in the utilization of calcium given by the bones, and even in the face of extreme calcium depletion, that which comes from the bones is always excreted. The bones are replenished by the calcium absorbed by the digestive tract.

Doctor Garlock stated that there was no question but that excellent results were being obtained by Doctor Bernheim in the Peripheral Vascular Clinic at the New York Hospital in the relief of vasospasm in all forms of peripheral vascular disease by adequate calcium therapy. It would be obvious to any impartial observer following these cases over a sufficient period of time. Doctor Garlock contended that in those cases which fail to respond to such treatment, initial compensatory or functional hyperplasia has resulted in irreversible changes in the parathyroid glands, and that in these cases parathyroidectomy is indicated. He felt that this condition, though obviously different from hyperparathyroidism of von Recklinghausen's disease, is nevertheless a disease of the parathyroid glands.

In answer to Doctor Parson's question concerning the calcium tolerance test mentioned in the paper, Doctor Garlock stated that an effort was made not to dwell too extensively on this point because Doctor Bernheim was not ready to make any definite statements about the value of this test. For the past three years Doctor Bernheim and her co-worker, Doctor London, have

been attempting to develop a test of parathyroid activity, and up to the present time this is exemplified by their calcium tolerance test. Briefly, it consists of the injection of calcium gluconate intravenously on a fasting stomach and then the estimation of the blood calcium and phosphorus at varying periods up to two hours later. A curve is then plotted and this is compared with the so-called normal curve. Of course, it is realized that it will be necessary to obtain many hundreds of so-called normal curves before any definite conclusions may be drawn as to the value of the test. However, up to the present time, some very significant abnormalities have been encountered in a number of diseases having disturbances of calcium metabolism.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD OCTOBER 24, 1934

The President, Dr. Allen O. Whipple, in the Chair

FIBRINOPURULENT PERITONITIS FOLLOWING ACUTE APPENDICITIS

Dr. Philip C. Potter presented a man of 40 who was admitted to the First Surgical Division of Bellevue Hospital on November 5, 1932, complaining of moderate abdominal pain of 18 hours' duration, localized at first in the epigastrium but later extending over the entire abdomen. There were no urinary symptoms, nausea or vomiting. The past history was negative except for inconstant upper abdominal discomfort following meals. On the evening of admission the temperature was 103°, pulse 145, blood pressure 140/100, leukocytes 13,000—77 per cent, the urine negative. The abdomen was markedly distended and tense, with liver dulness one inch above the costal margin. There was tenderness over the entire abdomen but this was most marked just below and to the right of the xiphoid. A diagnosis of ruptured gastric ulcer with diffuse peritonitis was made.

Operation under spinal anesthesia through a right split rectus incision disclosed thick yellow colon pus throughout the abdomen with little attempt at walling off. There was likewise a collection in the pelvis. There was a ruptured gangrenous appendix with gangrene of the cecum about the base of the appendix for a distance of 3 cm. As much of the small intestine as could be seen was injected and adjacent coils adherent. The pus was aspirated, the appendix ablated, and the stump together with the involved portion of cecum inverted with No. 1 chromic catgut. A single cigarette drain was placed just through the peritoneum and the abdominal wall closed loosely in layers.

Following operation the patient was given a continuous infusion of 5 per cent glucose in normal saline, and pitressin, 1 cc. intramuscularly every two hours. There was moderate distention for the first week which was relieved by a daily colonic irrigation. The temperature at the end of this time had reached normal, the patient was taking food by mouth and the bowels were moving. On the eighth day there were signs of disruption at the upper end of the wound. The abdomen was again opened under gas-oxygen anesthesia and the pathology found to be essentially the same as at the time of the first operation. The coils of small intestine were glued together and there was a considerable amount of thick yellowish pus present. The abdominal wound was grossly infected with practically no sign of repair. Through-and-through retention sutures of heavy silk were inserted and tied through buttons at either side of the wound, effectually closing the peritoneum and transversalis fascia and leaving the superficial portion of the wound open for drainage. The remainder of the course was uneventful. The sutures were removed at the end of two weeks, and the walls allowed to fall together. The patient left the hospital on the twenty-ninth day in good condition and with what appeared to be a strong abdominal wall.

The points of interest in this case were (1) the short history and the relatively mild symptomatology in view of the pathology found at operation;

(2) the degree of peritonitis found on opening the abdomen for the second time, at which time the patient was taking food and the intestine was functioning normally; (3) the error in closing more than peritoneum and transversalis fascia at the time of the first operation.

Dr. Frederic W. Bancroft considered this case of interest because there were so few symptoms in the presence of a persistent peritonitis. He felt that undoubtedly the use of pitressin as advised by Doctor Potter had been of considerable importance. He felt that he would like to bring up for discussion in relation to peritonitis the Ochsner treatment of appendicitis when complicated by peritonitis. At a recent meeting of the American College of Surgeons in Boston Doctor Bancroft had discussed this problem with two or three surgeons and had been impressed by the favorable reports they had submitted in cases so treated. They believed that where abscess or peritonitis was present operation should be delayed until the process had subsided. Men interviewed stated that they gave morphine until the respirations had been slowed down to 12; they gave nothing by mouth, no colon irrigations were given, they did not administer pitressin, and they stressed the importance of administration of at least 3,000 cc. of saline daily, either by hypodermoclysis or infusion. They stated there was very little distention. Doctor Bancroft felt that perhaps this method should be tried more in the late cases of peritonitis.

Dr. Frank B. Berry, referring to the use of pitressin, stated that on the First Surgical Division, Bellevue Hospital, they have used it for two or three years. Before they began its use the mortality in acute diffuse peritonitis was 35 per cent; since then the series has run about 17 per cent. One point of interest about its use is that there is no increased peristalsis; it merely causes contraction of the intestine. Its use also makes less work in nursing care. Occasionally one finds a patient who has an idiosyncrasy to pitressin; the speaker had seen three such cases, two recently and one several years ago.

Doctor Potter, in closing, referred to recent discussions in regard to the treatment of diffuse peritonitis. While the Ochsner method may sometimes be used to advantage in the case of a localized abscess, he felt that it was a dangerous procedure to follow in the presence of a diffuse infection of the peritoneal cavity. In answer to Doctor Berry's remark concerning an occasional idiosyncrasy to pituitary extract, the following has been Doctor Potter's experience in 1,200 abdominal cases in which pitressin has been used as a routine postoperative measure. Blanching of the skin of the face and extremities, without change in pulse or blood pressure, has been frequently encountered and is of no clinical importance. Occasionally a patient has vomited following every injection of pitressin. Ten cases of shock have been observed. This has been characterized by a sudden fall in blood pressure and blanching of the skin. All have responded to adrenalin and fluids and there have been no fatalities. In eight of these cases previous doses of pituitary extract had

caused no reaction and Doctor Potter felt that the fall in blood pressure had been brought about by the accidental introduction of the drug into a vein in the region of the deltoid muscle. Recent experiments in which pituitary extract has been introduced intravenously in dogs bear out this assumption.

MECKEL'S DIVERTICULUM ATTACHED TO ROOT OF MESENTERY

DR. PHILIP C. POTTER presented a boy, aged 16, who was admitted to the First Surgical Division, Bellevue Hospital, October 16, 1933, complaining of cramp-like pain in the lower abdomen for the past two weeks. He had been nauseated at the onset of symptoms. There was no history of any previous abdominal discomfort. Castor oil had been administered on the day preceding admission with considerable increase in the pain. On physical examination there was marked tenderness in the right lower quadrant, and tenderness to the right by rectum. No mass was felt. Leukocytes were 7,250, polynuclears 90 per cent. The urine was negative. A diagnosis of acute appendicitis was made.

At operation under spinal anesthesia, a normal appendix was found. At a point 20 inches from the ileocecal valve there was a diverticulum, four inches in length, shaped like a glove finger, with a lumen approximately two-thirds that of the adjacent intestine. Attached to the tip of the diverticulum there was a cord of firm tissue which extended downward and to the right to fuse with the base of the left leaf of the mesentery at a point eight inches from the ileocecal valve. There was no indication of inflammation or ulceration of the wall of the diverticulum, nor was there any sign of obstruction or torsion as the result of the anomalous attachment of the cord. The diverticulum was resected and the appendix removed. The postoperative course was uneventful. Pathologic report: normal small intestinal wall. There was nothing resembling gastric mucosa.

Comment.—Whether the symptoms which this patient presented on admission were the result of the anomalous attachment of a Meckel's diverticulum is of course open to question. However, distention of a portion of small intestine, fixed as this was to the root of the mesentery, might well produce the rather mild symptoms of which he complained.

JEJUNAL ULCER FOLLOWING GASTRIC RESECTION

DR. FREDERIC W. BANCROFT presented a male, aged 49, admitted to the Fifth Avenue Hospital May 31, 1931, who had been treated on a medical service six months previously when his condition was considered to be a partial perforation of a postpyloric ulcer. He had been treated in the interval dietetically and medicinally, but for the preceding two weeks there had been a marked increase in the intensity of his pain which occurred after eating and at night. Roentgen rays showed a progressive postpyloric ulcerative involvement. Operation June 31, 1931, disclosed a large ulcer on the anterior surface of the duodenum covered with a shaggy membrane and an ulcer on the posterior superior surface which apparently had penetrated all layers. There was marked induration and inflammatory reaction about the duodenal cap. A modified Devine gastrectomy with Pólya retrocolic anastomosis was done.

Eighteen months later, it was found that there had been a return of epigastric distress situated, however, in the left upper quadrant, severe in character, occurring after eating, with anorexia. He had been under con-

tinuous nervous strain because of economic conditions, slept poorly, eaten irregularly and smoked incessantly. On March 1, 1933, 22 months after his gastrectomy, he was readmitted to the medical service at which time he gave definite radiologic evidence of a jejunal ulcer (Fig. 1). It was felt that the disturbed mental condition and irregular habits in conjunction with a number of infected root cavities predisposed to his present complaint. No operative interference was instituted.

Present Condition.—October, 1934, one year ago, patient regained control of his business and his economic condition was readjusted. Very shortly after this his epigastric distress ceased (Fig. 2). He now works from 10 to 14 hours a day, has gained 20 pounds in weight, eats, drinks and smokes what and when he wishes and has no distress referable to his stomach.

This case is presented because it is believed that it illustrates the ill effects and morbidity resulting from economic stress and marked nervous depression and it is felt that during such times as at present, unless a patient is on a fair economic status and relatively happy, surgery should be postponed as long as feasible and that if operation should be necessitated, it should be the last procedure that offers hope of relief.

Dr. Seward Erdman said that in a discussion of the etiology of ulcer, Doctor Bancroft's point was well taken, in that the emotional element has much to do with the production of peptic ulcer. This case illustrated how the stress and strain of modern life were factors in the production of this ulcer of the jejunum. The speaker wondered if Doctor Bancroft's therapy had produced temporary relief and not a cure. Marginal ulcer is more difficult to cure by a dietetic régime than a primary duodenal ulcer, but he has seen cases of jejunal ulcer which have healed on the indicated diet. In regard to resection, Professor Nystrom stated that the figures for jejunal ulcer following gastric resection in Germany were over 1 per cent. Figures of that sort are liable to expansion. The term "marginal ulcer" is not appropriate. These ulcers formerly were attributed to trauma. If clamps were used they might have injured the mucous membrane, or they might have been due to the use of nonabsorbable material. In two recent autopsies on cases of jejunal ulcer following gastro-enterostomy, the ulcers were so definitely jejunal that they could not be called marginal. The development of secondary ulcer symptoms is so much delayed that it is unreasonable to attribute them to operative trauma.

Dr. Richard Lewisohn stated that he agreed with Doctor Erdman that Doctor Bancroft's case could not be classified as a gastric resection. The Devine operation does not represent a partial gastrectomy, but rather a modified Eiselberg operation. He doubted whether this patient was cured. Gastrojejunal and jejunal ulcers present the same life cycle as duodenal ulcers. It is possible that in the future this patient will have a recurrence of symptoms. Doctor Lewisohn asked Doctor Bancroft whether a test meal had been done recently upon this patient.

Dr. Henry F. Graham stated that Alvarez, speaking of gastro-enterostomy, has said: "The most dangerous of all is gastro-enterostomy with

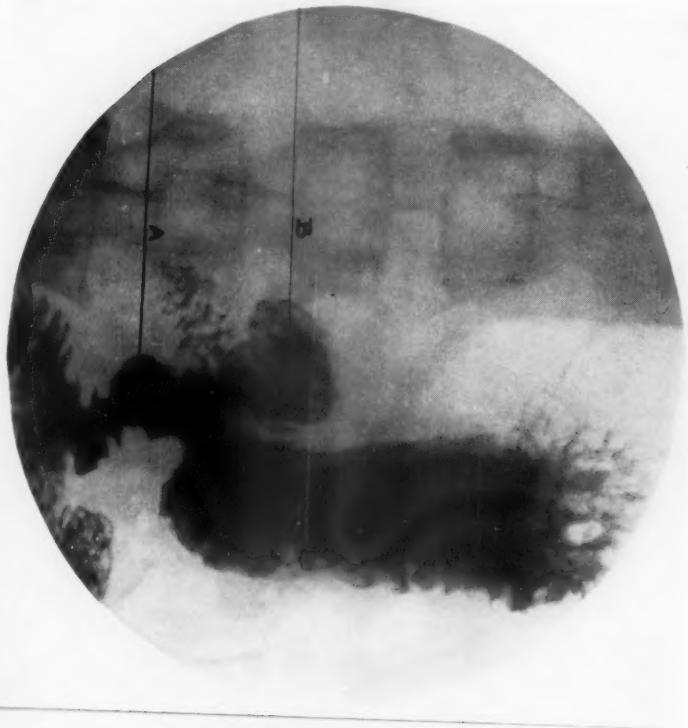


FIG. 1.—Patient J. S., Feb. 18, 1933. (A)—Jejunal ulcer. Some dilatation of proximal loops. (B)—Fossa of Treitz.

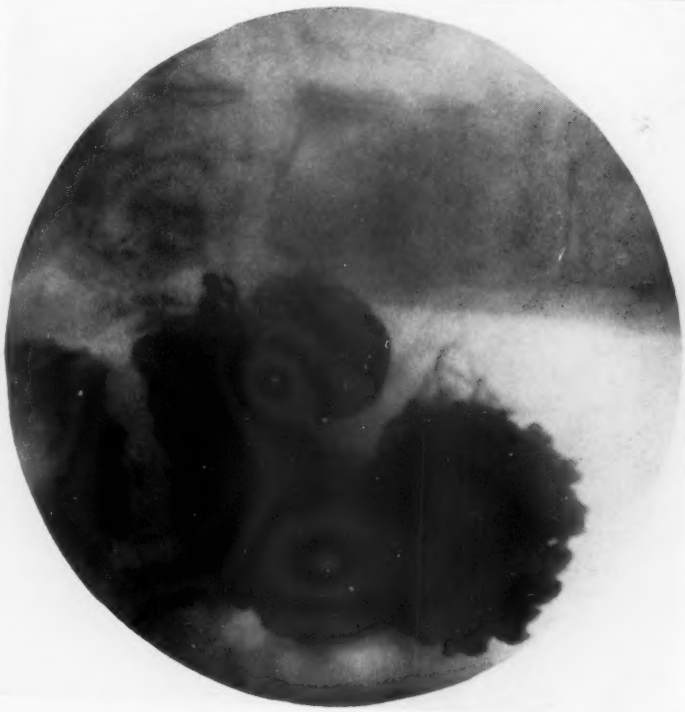


FIG. 2.—Patient J. S., Oct. 22, 1934. Disappearance of ulcer. Fairly healthy appearing stoma. Some dilatation of proximal loop at fossa of Treitz.

Von Eiselberg's closure of the pylorus. In some clinics one out of four patients so operated upon has returned with jejunal ulcer." This would seem to be due to lack of stimulation of the secretion of bile and pancreatic juice which normally occurs when the gastric chyme is poured into the duodenum, and also to lack of normal duodenal peristaltic waves. Balfour, however, says that the Devine operation is seldom followed by jejunal ulceration although Denk has reported two such cases. This report of Doctor Bancroft's case makes the comments of Alvarez still more interesting.

Doctor Bancroft, in closing, said that he disagreed with Doctor Lewisohn. He believed that in the modified Devine operation where the mucous membrane is combed out from the re-entrant angle to the pylorus and the musculature is turned in, in general the same procedure had been produced as in a moderate gastric resection. Anastomosis of course in this case was a retrocolic Pólya type. The advantage of this particular type of operation Doctor Bancroft considered was in those cases where the ulcer was adherent to the pancreas and mobilization and dissection was accompanied with considerable risk.

Doctor Bancroft said that he had not analyzed the gastric contents for acidity in the case reported and that he was inclined to feel that the patient's sense of well-being, with absence of any symptoms of indigestion, was a better indication of a patient's condition than could be determined by the presence of hyperacidity or anacidity. He believed that the patient's cure had been largely due to the relief of nervous worries and the financial security due to a steady job.

BILATERAL TRANSPLANTATION OF URETERS FOR EXSTROPHY OF BLADDER

Dr. Frederic W. Bancroft presented a male, aged five months. Admitted to the Fifth Avenue Hospital because of complete exstrophy of the bladder. Examination showed both ureteral orifices were present; there was a moderate separation of the symphysis, also an umbilical hernia. It was decided to do a transplantation of the ureters into the sigmoid. It was felt in such a small child the Coffey No. 1 or No. 2 would not be feasible; it would not be possible to insert a proctoscope or gauze into the sigmoid; a Coffey No. 3 was decided upon which has to be done in two stages and which depends upon end ligation and transplantation of the ureter and then a stitch being inserted through part of the ureter and the mucous membrane of the sigmoid, assuming that sloughing will occur shortly thereafter.

Operation.—Nov. 21, 1932. Transplantation of left ureter into sigmoid (Coffey No. 3). As the exstrophy extended almost to the umbilicus, it was thought necessary in order to obtain a satisfactory exposure to make a right-angled incision. As the child was anesthetized, the left ureter was catheterized and the catheter left in place. The region of the exstrophy was then walled off from the region of the general incision by a large rubber dam apron. Sigmoid was easily exposed, ureter readily identified and dissected free almost to the bladder, care being taken to preserve the periureteral structures. It was ligated near the bladder and cut, the proximal end being left unclamped. Clamp was then placed on the periureteral tissue for traction and a probe

inserted into the lumen, catheter having been withdrawn previous to the ligation. Incision about 3 cm. long made on the anterolateral portion of the sigmoid. The serosa and muscularis were cut. As the sigmoid wall was very thin, the operator was not entirely satisfied that he had dissected free all of the muscularis. Tissue was split with a fine hemostat as in a Rhamstedt operation. At the proximal end of the incision in the sigmoid, the ureter was inserted and interrupted sutures placed over it. When it came toward the distal end, a doubled silk ligature was inserted through the lumen in the ureter, following closely around the probe. Suture was then passed through the mucosa of the intestine and tied tightly. The end of the ureter was then ligated with heavy catgut. The distal part was then implanted as the proximal portion had been, ligature being caught in one of the suture knots in order to prevent retraction of the ureter.

The child had a postoperative pneumonitis, followed by eventration of the longitudinal portion of the wound. The transverse rectal incision held. Four days postoperative, the wound was repaired. Thereafter his convalescence was moderately stormy, but he progressed fairly well and was discharged from the hospital. He was readmitted Dec. 20, 1932.

Secondary Operation.—April 31, 1933. Second-stage Coffey operation with transplantation of the right ureter. Catheter was first inserted into the right ureter. An incision was then made excising the umbilical hernia and extending downward along the left side of the exstrophy. The sigmoid was moderately dilated and there were some adhesions beneath the previous scar. No attempt was made to explore the site of the previous transplant. The right ureter was dissected free, care being taken to preserve the areola tissue about it, and it was dissected downward almost to the bladder and ligated. The catheter was removed and a probe inserted into the proximal end. It was decided to place it at right angles to the bowel and an incision was made through the peritoneal and muscularis for a distance of about 3.5 cm. The end of the ureter was then tied with heavy catgut and anchored in the proximal portion of the incision with a fine silk suture. A transfixing suture of silk was inserted about midway through the lumen of the ureter and this was passed into the lumen of the bowel and tied. The muscularis was united over the ureter with interrupted silk sutures. Peritoneum was closed over the ureter beyond where it was sutured to the bowel. The bladder was dissected free from the anterior peritoneal surface down to the trigone. The mucosal part of the trigone was then inverted by interrupted mattress suture. The area of defect was too large to attempt bringing the skin across so that an area of about 2 cm. in diameter was left to granulate.

The postoperative course was complicated by the development of chicken pox, Pott's disease and pertussis. September 7, 1933, roentgen ray with skiodan showed prompt secretion from both kidneys. The calyces are the same in size and shape as in the previous examination made in January. The pelvis of the right kidney is a trifle larger than at that time. The kidneys are the same in size, shape and position.

Subsequent Course.—This child has grown and is now beginning to walk. On previous admissions he would develop, about once a week, an elevation of temperature with evidences of some moderate nitrogen retention. It has been found that if he is given two or three saline colon irrigations a week, his temperature will remain normal.

The case is of interest because a first-stage Coffey operation was performed for marked exstrophy of the bladder at the age of six months. This was done

about two years ago and the child is showing evidence of normal growth and relatively normal health. No attempt has been made to operate upon the epispadias, but in the excision of the bladder care was taken not to injure the verumontanum. If he lives to approaching puberty, it would seem advisable to attempt then a surgical procedure for the epispadias.

Dr. Edwin Beer stated that the operation illustrated by Doctor Bancroft's case of exstrophy of the bladder deserved a great deal of consideration and attention, because the indications for ureteral transplantation are steadily growing. The late Dr. R. L. Coffey deserves a great deal of credit for his persistence in developing various technics for this operation. In all he has advocated three different methods of uniting the ureters to the bowel, and all of these were based on animal experimentation. Despite the fact that he had developed these three different methods, Doctor Coffey told the speaker himself only recently that in no single case had he been able to employ his experimental work in human beings before somebody else had done each one of the procedures which he recommended. His fundamental idea was that of oblique implantation of the ureters into the bowel so that in its course through the submucosa a valvular compression of the ureter would take place and prevent regurgitation. His study of the insertion of ducts in the human and in animals into hollow viscera had suggested to him that this was nature's method of protecting the implanted organ.

Strange to say, although everybody is inclined to make such oblique implantations of the ureter as suggested by Coffey, in the bladder, where such implantations are practically impossible and direct introduction of the ureter in the bladder has to be carried out, the neostomy under these conditions functions perfectly. This has been proven by filling the bladder with opaque fluid in six or seven cases, in which no reflux of iodide took place up the ureters. This makes one a little skeptical as to the necessity of an oblique implantation into the bowel.

There is no doubt in Doctor Bancroft's case that the left ureter is already somewhat dilated, which suggests an obstructive condition at the anastomosis, and there is also no doubt that such dilatations may continue for years without impairing the patient's health. All in all, this operation, no matter whether the first, second or third technic of Coffey is employed, relieves the patient of great discomfort and is highly successful in the majority of cases. Doctor Beer himself recently saw a case which was done by Doctor Hartley in 1894 at Roosevelt Hospital. The patient had enjoyed relatively good health, except for attacks of pyelonephritis which led to calculi and pyonephrosis and eventual death thirty years after operation.

The first technic of implanting the ureters obliquely into the bowel, known as Coffey No. 1, consists of a two-stage operation, the ureters being transplanted one at a time. The second technic is a simultaneous bilateral implantation of the ureters with intubation of the ureter anastomosis. Coffey's third technic consists of transplanting one ureter at a time and using a cutting

through ligature between the ureter and rectum or sigmoid to make the anastomosis, very much like the McGraw ligature used in gastro-enterostomy. This latter technic requires two separate operations. It has been modified so there can be a simultaneous anastomosis of both ureters by Doctor Higgins of the Cleveland Clinic, who leaves the ureters running into the bladder and makes a lateral strangulating suture between each ureter and the bowel at the original operation. The urine continues to run down into the bladder through the nonobstructed ureter, while the cutting through ligature establishes a lateral anastomosis. At a subsequent operation the ureter beyond the anastomosis is tied off and cut away and the stump buried. This ingenious improvement surely deserves careful trial.

The indications for the operation of ureterosigmoid anastomosis, as Doctor Beer has said, are much more extensive than is generally thought. In exstrophy of the bladder or uncontrollable epispadias this is the only operation which will give any adequate relief, despite the fact that Young recently, in a visit to New York, did not speak very favorably of this procedure, and still was inclined to produce or reconstruct a new bladder out of what was left by nature. In incontinence cases where the sphincter has been damaged or where a very large nonclosable vesicovaginal fistula is present this operation is a Godsend to the sufferer. Again in patients whose bladders have been removed for carcinoma of the bladder it may prove a valuable aid in sidetracking the urine, either preliminary to or simultaneous with the total cystectomy. Another indication is in chronic contracted bladder with great frequency such as is occasionally seen after tuberculosis or other vesical inflammatory conditions. The end-results are surprisingly good, though the patient may have on and off mild pyelitis or pyelonephritis. Still many years of useful activity are given these cases and the effect on the upper urinary tract can readily be controlled by excretory urography, which prior to 1929 could not be done. The sphincter of the rectum controls the new condition very well, so that the patient may have to void only three or four times during the day, and at times will sleep through the night without emptying the bowel.

Dr. W. Howard Barber stated that judging by experiments he performed some years ago, the oblique feature of the Coffey operation was very important. The best results are obtained when the length of the intramural segment of transplanted ureter lies between 2 and 2½ cm. The speaker wondered if Doctor Bancroft recalled if there was any difference in the lengths of the intramural segments.

Doctor Bancroft replied in closing, to Doctor Barber, that he did not recall any difference in the anastomosis of the two sides except that the anastomosis on the left side was inserted parallel to the long axis of the sigmoid while the right ureter had been implanted at right angles to the long axis. This latter procedure was done in order not to disturb the adhesions from the first implantation. The child had never complained of any pain referable to either kidney and the temperature elevation which previously had occurred

about once a week now had been cut down so that at present he had about one elevation in two or three months. This was largely due, he believed, to the colon irrigations of normal saline given twice a week.

MECKEL'S DIVERTICULUM

Dr. Charles E. Farr read a paper, written by himself and Dr. Madeline Penke (by invitation), with the above title for which see page 1026, Annals of Surgery, vol. 101.

Dr. Frank S. Mathews said that when he had personally encountered 12 Meckel's diverticula he collected his histories and contributed a short paper to the Arch. of Surg., in 1925. Since then he has seen two cases with acute symptoms. In speaking to others, they have expressed surprise that such a large percentage of them have been clinical cases rather than accidental findings of diverticula. Only three of the fourteen have been entirely asymptomatic. They have shown infections, obstructions, intussusceptions, volvulus and hernia into an umbilical cord in the newborn. Curiously, the latter has been the only one in which the diverticulum was attached to the umbilicus. Attachments elsewhere and by the tip of the diverticulum have been not uncommon. The method by which the tip has become attached to the root of the mesentery and to the bottom of the hernial sac is rather obscure. Adhesions of lateral margins have not been seen. At times the tip has been attached by a fibrous cord. He recalls no pathologic report of gastric mucous membrane and none of his cases has had rectal bleeding as a symptom. In a number, the specimen has been gangrenous so that gastric mucosa would not have been recognized even if present. Doctor Farr's four cases illustrate two well-recognized findings, namely, intussusceptions from an inverted Meckel's and hemorrhages as a result of ulceration of the mucosa.

Case Reports.—Brief report of his last two cases may prove of interest. Case I.—A woman, 50 years of age, seen after an illness of several days, gave a very obscure history in which abdominal pain and nausea with slight temperature and slight leukocytosis were prominent. Enemas were moderately effective. The need of operation was demonstrated by two roentgen ray exposures. First, a plain plate of the abdomen showed gas in intestinal loops and a clysma showed that the colon was not involved. It was then thought that she had a partial obstruction probably from a band following an appendectomy in which the appendix was said to be normal. At operation a black mass was seen in the lower abdomen adherent to the omentum and adjacent bowel. On separating adhesions, it was found to be an entirely gangrenous mass with an attachment not larger than a lead pencil. The gangrene was a result of rotation on its long axis. The symptoms suggesting partial obstruction were due to adhesions rather than to an actual closure at the point of attachment. Further, the distention of the bowel was only moderate.

Case II.—A child of three and a half, ill for ten hours with abdominal pain and vomiting. Shortly after a physician felt a mass in the right abdomen. An enema was ineffectual and there was no blood. The child was a little older than the usual case of intussusception but intussusception seemed the most likely diagnosis. Incision revealed distended bowel. The cecum was brought

out and found not to be intussuscepted but the small bowel was found distended for a number of inches up to the ileocecal valve. On reducing an intussusception which occupied eight or ten inches of the bowel, a diverticulum three-quarters of an inch long with its mesentery lying on the side of the bowel was then found inverted, forming a polyp. It was removed without resection and it is of interest to note that in the 14 cases which the writer has observed the diverticulum was removed without resection in all but one; and that was a neglected case in which the diverticulum with intussusception was ruptured in the attempt to deliver it through the abdominal incision. He said that he considered it quite unusual for one to have encountered 14 Meckel's diverticula all in the course of clinical work and with most of them presenting a pathology requiring operation.

Dr. Emil Goetsch said that he had operated upon two cases of intestinal obstruction due to a Meckel's diverticulum in neither of which had intestinal hemorrhage occurred. The first patient was a woman of about 50 who complained of a persistent intestinal colic which had continued over a period of several days and which was not relieved by medication. After a few days' observation during which time the colic became more severe, laparotomy was performed and a rather large Meckel's diverticulum with a wide base found. The diverticulum was firm and resistant as well as the segment of bowel opposite the opening of the diverticulum. Both were filled with some substance, the nature of which was not determined until a small incision was made into the diverticulum which was found to be filled with a material that resembled very much a brown filamentous substance of the nature of excelsior. These substances had occluded the lumen of the small bowel as well as the Meckel's diverticulum and had produced a moderately severe intestinal obstruction. It was feared that the obstruction might not be relieved by resection of the diverticulum and a plastic repair, because the base was too wide and a secondary obstruction might be caused by plastic repair of the base. Accordingly the small bowel was resected on either side of the diverticulum and a lateral anastomosis performed. It appeared subsequently that this patient had been on a reducing régime and had been taking an undigestible mixture of bran and agar which was caught in the diverticulum and finally caused obstruction of the small bowel at its base. Patient made an uneventful recovery.

The speaker reported the case which Doctor Farr alluded to in the Johns Hopkins Bulletin in 1919. It was that of a boy 19 years old who had been operated on six years before for what was called "stomach abscess." He was now suffering from a very severe intestinal obstruction. A vertical scar was seen immediately below the umbilicus. At operation a fairly long Meckel's diverticulum was found adherent together with a mass of omentum to the anterior abdominal wall at the point of the old scar. The small intestine had become looped over the diverticulum and had thus become obstructed. The diverticulum was extirpated and patient made an uneventful recovery. Upon examination it was found that there was an area of thickened, cherry-red, granular mucosa covering the distal third of the lumen while that of the proximal two-thirds resembled intestinal mucosa. On microscopic examination, the

thickened mucosa at the tip of the Meckel's diverticulum proved to be typical gastric mucosa of the fundus type. The proximal mucosa was of the intestinal type and resembled ileal mucosa. Special staining methods were employed and both the parietal acid cells and the chief cells characteristic of the fundus of the stomach were clearly demonstrated. A thorough search of the literature showed that this was the first instance reported up to 1919 of proven gastric mucosa in a Meckel's diverticulum. Previously gastric mucosa had been described at the umbilicus and in umbilical fistula and this case completed the findings of gastric mucosa from Meckel's diverticulum to the umbilicus and thus explained the occurrence of this type of heterotopic gastric mucosa as due to developmental errors arising in the embryonic omphalomesenteric duct. In this case under discussion, it is probable that the so-called "stomach abscess," for which the patient was operated upon previous to the occurrence of intestinal obstruction, resulted from perforation at the tip of the Meckel's diverticulum due possibly to a small ulcer at the junction of the gastric and intestinal mucosa. Subsequent healing of this ulcer and perforation revealed no evidences of itself at the time of the extirpation of the diverticulum. Instances of this nature have been described.

Dr. Morris K. Smith said that he was especially interested in the cases in which there was bleeding from the bowel because he had encountered two similar cases. The first was in a boy five years old who had suffered from repeated hemorrhages. While at Nursery and Child's Hospital he developed signs of peritonitis. At operation a Meckel's diverticulum was found with a perforated ulcer adjacent to it. The diverticulum contained gastric type of mucosa. In the second case there was an intramesenteric diverticulum of the small intestine, the adjacent bowel was inflamed and there appeared to be an ulcer. The child's condition did not permit a resection in this instance so that pathologic findings are not available.

It was Doctor Smith's impression that if there is bleeding due to Meckel's diverticulum gastric-like mucosa will usually be found in the diverticulum and an ulcer will be present in a considerable percentage of cases. He wished to call attention to the point Doctor Farr emphasized, namely, that in cases of unexplained bleeding from the bowel in children a Meckel's diverticulum should be considered as a possible cause.

Dr. Allen O. Whipple asked if Doctor Farr knew of any case in which roentgen ray diagnosis of a Meckel's diverticulum had been demonstrated or proven at operation or autopsy. At the Presbyterian Hospital they have not been able to find any proven case diagnosed Meckel's diverticulum in the roentgen ray department.

Doctor Farr, in closing, replied to Doctor Whipple that in his experience none of the roentgenologists are willing to make a diagnosis of Meckel's diverticulum, but he had read of one case in which the diagnosis had been made. The barium cannot get into these small mouthed openings. In two

of the speaker's cases the roentgen ray diagnosis of intussusception was made, in one case correctly.

A case of a man, 70 years of age, was presented through the courtesy of Dr. James T. Pilcher for exhibition at the New York Surgical Society, the history being that ever since birth there had been a protruding mass at the navel which occasionally became irritated and bled moderately. This man was examined by Dr. Arpad Gerster in 1888 and was advised not to have an operation.

Examination shows a protruding mass at the navel about 3 by 2 cm., conical (Fig. 3), of a bright scarlet or cherry-red—a most unusual color. It is not tender. It secretes slightly at all times, and, as previously stated, it

FIG. 3.—Appearance of tumor at umbilicus.

bleeds, especially after slight trauma. No biopsy has been performed. The secretion is amphoteric in reaction. A small amount of secretion was examined for hydrochloric acid by the Günzburg test and gave a moderately positive reaction. There has been no evidence by roentgenography nor by probing of a communication with the bowel. This probably represents a remnant of the omphalomesenteric duct, persisting at the navel and atrophic in the proximal portion, that is, the part nearest the bowel. There may, of course, be a true Meckel's diverticulum in addition to the protruding part.

BRIEF COMMUNICATION

LYMPHOSARCOMA OF THE STOMACH

REPORT OF A CASE WITH A NINETEEN-YEAR SURGICAL CURE

BECAUSE of the rarity of sarcoma of the stomach and because it is extraordinary for a patient to survive for any period of years, we are recording the following case history of a patient who is living and without evidence of recurrence over nineteen years after a partial gastrectomy for lymphosarcoma of the stomach.

The patient, a white boy, aged nine years, was admitted to St. Vincent's Charity Hospital June 12, 1914, complaining of abdominal pain, nausea and vomiting. His illness

FIG. 1.—Gross specimen of lymphosarcoma.

had started about a year previously when he had been struck in the "pit of the stomach" by a baseball and had been rendered unconscious for a short period of time. From then on, he had complained of aching discomfort in the epigastrium. He would not play and was content to sit around, because exercise aggravated his discomfort. About two months before his admission to the hospital, he had begun to have attacks of vertigo associated with nausea and vomiting. These became progressively worse until he was unable to retain any food or water, and he would go to sleep for long periods of time and appear as if he were dead.

The examination revealed an underdeveloped and undernourished boy, aged nine years, who weighed scarcely fifty pounds. Fullness was noted in the upper abdomen and on palpation a tender tumor mass about ten centimetres in diameter could be felt. The examination otherwise revealed nothing of significance. A clinical diagnosis of sarcoma of the stomach was made by Dr. F. E. Bunts and at operation he found a large mass involving one-third of the pyloric end of the stomach with glandular enlargement of the greater curvature. A partial gastrectomy and a posterior gastro-enterostomy were performed.

Postoperatively the patient made an uneventful recovery. He remained in the hospital for two weeks, when he was able to return to his home. He could retain all foods, and although he complained of being dizzy at times, and that he was not at all normal, he gained weight rapidly and in five or six months had resumed normal activity.

FIG. 2.—Section of lymphosarcoma.

The surgical specimen weighed a little over 900 grams. The process had extended laterally through the submucosa, with invasion of the muscle layers, and appeared as a diffuse infiltration of the stomach wall. Microscopically, a large number of small mononuclear cells predominated the picture and a pathological diagnosis of small round-cell sarcoma was made. Although this is the extent of the pathological report available, we have a photograph of the tumor (Fig. 1) and a photomicrograph of the section (Fig. 2). After careful review of the anatomical and clinical features and a study of the photomicrograph, we are of the opinion that this tumor should be classified as a lymphosarcoma rather than as a small round-cell sarcoma.

The patient was not seen again until May 1, 1917, when he was leading the life of a normal boy and had no complaints. He was able to eat everything, although he was not permitted to have much meat. He attended school regularly and his natural habits were normal.

April 21, 1927, in answer to a follow-up letter, the patient came to the Clinic. He

was then twenty-two years of age, and felt perfectly normal in every way except that he still had vertigo occasionally. This usually followed the ingestion of cereals or rich foods. His bowel habits were regular and he never became nauseated. His weight had always been a little below normal, and at the time of examination, he weighed 125 pounds and appeared slightly undernourished. The scar of his previous operation was noted. There were no herniations or abdominal masses palpable.

April 26, 1927, a complete series of röntgenological studies of the gastro-intestinal tract was done, and the report by Doctor Langan was as follows: "There has been a subtotal resection of the stomach with gastro-enterostomy. Aside from the operative deformity, nothing is seen suggestive of disease. The stoma is open and the stomach empties well."

April 25, 1933, the patient wrote that he was "enjoying perfect health and that he had a great appetite for all sorts of foods." He is five feet, eight inches tall and weighs about 130 pounds. He feels perfectly well and is leading a completely normal existence.

Comment.—After a careful search of the literature and a review of the reported cases of sarcoma of the stomach in patients living five years or more, it would appear that the patient just described has survived longer than any other patient with this type of tumor. Furthermore, this is the fourth reported case of sarcoma of the stomach in a child under ten years of age, and one of the few cases in children in which radical resection has been performed for sarcoma.

It is also interesting to note, from the review of the literature, that patients with lymphosarcomas comprise the greatest number of those surviving over the five-year period, in spite of the fact that this type of tumor has been judged the most malignant of the sarcomata.

THOMAS E. JONES, M.D.,
M. G. CARMODY, M.D.,
Cleveland Clinic, Cleveland, Ohio.

EDITORIAL ADDRESS

The office of the Managing Editor of the Annals of Surgery, James T. Pilcher, M.D., is located at 121 Gates Avenue, Brooklyn, N. Y. All contributions for publication, Books for Review, and Exchanges should be sent to the above address.

Remittances for Subscriptions and Advertising and all business communications should be addressed to the

ANNALS OF SURGERY
227 South Sixth Street
Philadelphia, Penna.